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TRACT C-A

ANNUAL PROGRESS REPORT

January 1980 — December 1980

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Rio Blanco Oil Shale Company

ANNUAL PROGRESS REPORT TRACT C-a

January 1980 — December 1980

OIL SHALE OFFICE
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Gulf Oil Corporation / Standard Oil Company (Indiana)
April, 1981

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RBOSC PROGRESS REPORT
JANUARY 1980 THROUGH DECEMBER 1980

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SECTION I

INTRODUCTION & SUMMARY

1.1 INTRODUCTION

The requirement to submit an Annual Progress Report (APR) on each anniversary date of the lease following approval of a development plan is contained in Section 1(c)(4) of the Environmental Stipulations to the Federal Oil Shale Lease (Serial No. C-20046) under which the Rio Blanco Oil Shale Company (hereinafter "RBOSC") is operating. The Gulf Oil Corporation and Standard Oil Company (Indiana) formed RBOSC as a general partnership to develop Tract C-a with the intention of engaging in the commercial production of oil shale. The legal description of Tract C-a, as defined in the Lease is:

T.1S., R.99W., 6th P.M.

Sec. 32: $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$

Sec. 33: All

Sec. 34: $W\frac{1}{2}$, $SE\frac{1}{4}$, $W\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$

T.2S., R.99W., 6th P.M.

Sec. 3: All

Sec. 4: All

Sec. 5: $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$ (incl. Lots 1, 2 and 3)

Sec. 8: $E\frac{1}{2}$

Sec. 9: All

Sec. 10: All

situated in the County of Rio Blanco, State of Colorado containing 5,089.70 acres, more or less.

This APR describes the operational programs on Federal Tract C-a from January 1, 1980 through December 31, 1980. An environmental monitoring report is being submitted separately for the Seasonal Year (December 1 - November 30) for air quality, meteorology, biological and hydrologic data. Since this Annual Report is defined to include a report on the monitoring programs, Section VII of this report contains a concise summary of the environmental programs for the 1980 Seasonal Year.

Approval to develop Tract C-a was received by RBOSC on September 22, 1977. The first reports which described operations from that date through the end of 1978 and 1979 were submitted to the Deputy Conservation Manager - Oil Shale (DCM-OS) in Grand Junction, Colorado in April of 1979 and 1980 respectively. They also contained a summary of environmental assessment and monitoring for the 1978 and 1979 Seasonal Year.

The information and background material contained in the previous reports is not included in the report. The previous reports were distributed by the Oil Shale Office (OSO) to many Federal, State and local agencies, libraries and private industry. It is on open file in many public places for reference and should be referred to for operational and monitoring information prior to 1980.

2.1 DESCRIPTION AND SCHEDULE OF PROJECT

At the end of 1980, RBOSC was approximately three and one-half years into a four and one-half year development program designed to determine the technical, economical and environmental viability of its modified in situ (MIS) recovery process. In 1979, the Modular Development Phase (MDP) program was changed to include three retorts. This program was described in detail in the previous APR. The MDP mine development configuration for Retorts Zero, One and Two are shown in Figure 1-2-1.

Retort Zero was ignited and burned as scheduled during 1980. Retort One will be ignited during the first half of 1981. Development of Retort Two will not begin until after the results of Retort One have been analyzed. This schedule restraint will delay Retort Two ignition until the end of 1982 or the beginning of 1983 depending upon when the decision point is reached.

During 1980 RBOSC decided to expand its demonstration program to include a surface retort to be constructed on land bordering the north of Tract C-a and develop an open pit for feed shale in the northwest corner of the tract. This is known as the Lurgi Demonstration Project. A Modification to the Detailed Development Plan was completed and submitted to the OSO in February, 1981.

Figure 1-2-2 illustrates the latest construction and operations schedule for the MIS program.

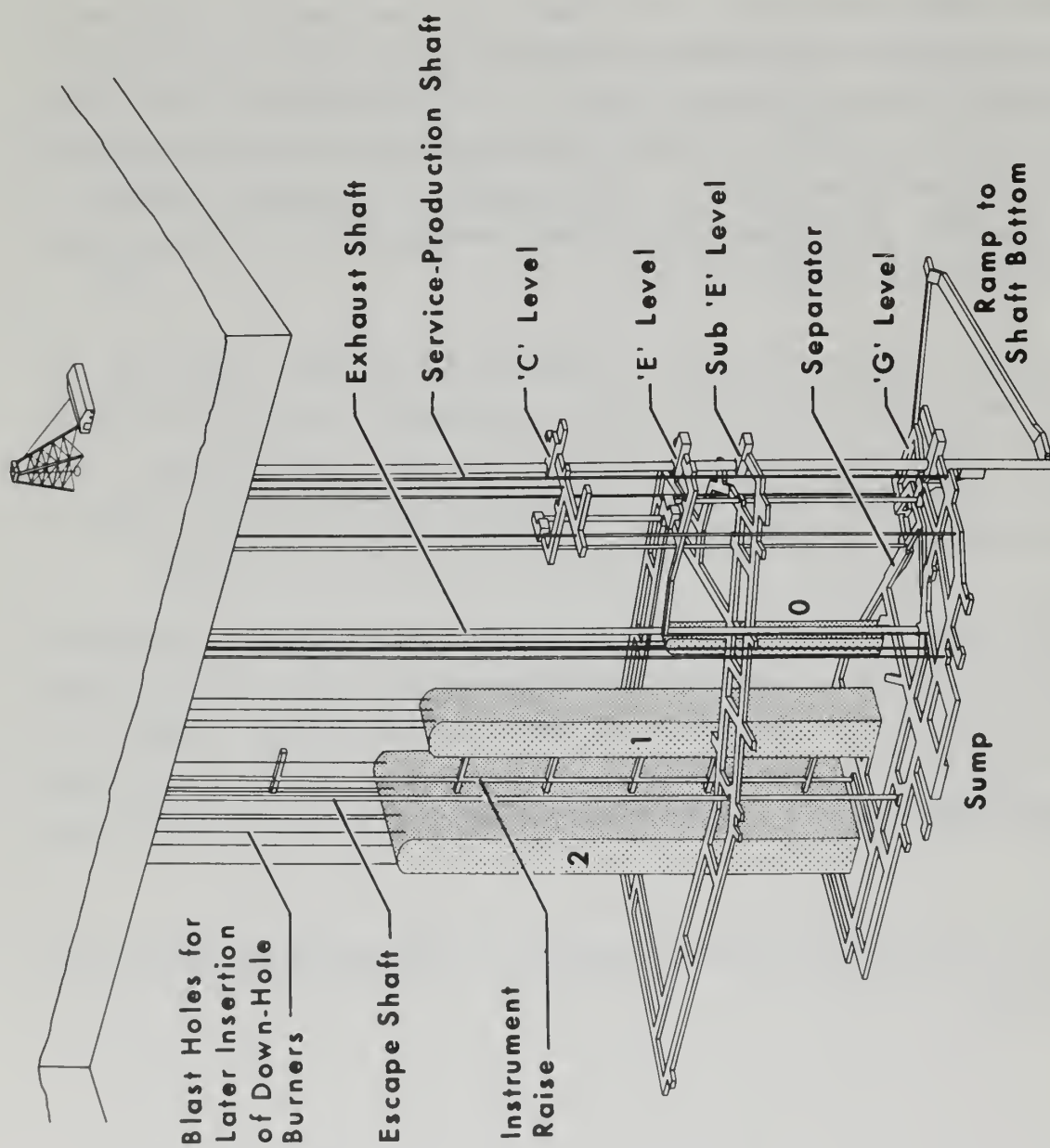


FIGURE 1-2-1

MDP MINE AND RETORT DEVELOPMENT PLAN

MDP Schedule Retorts 0, 1, 2, 3 & Up

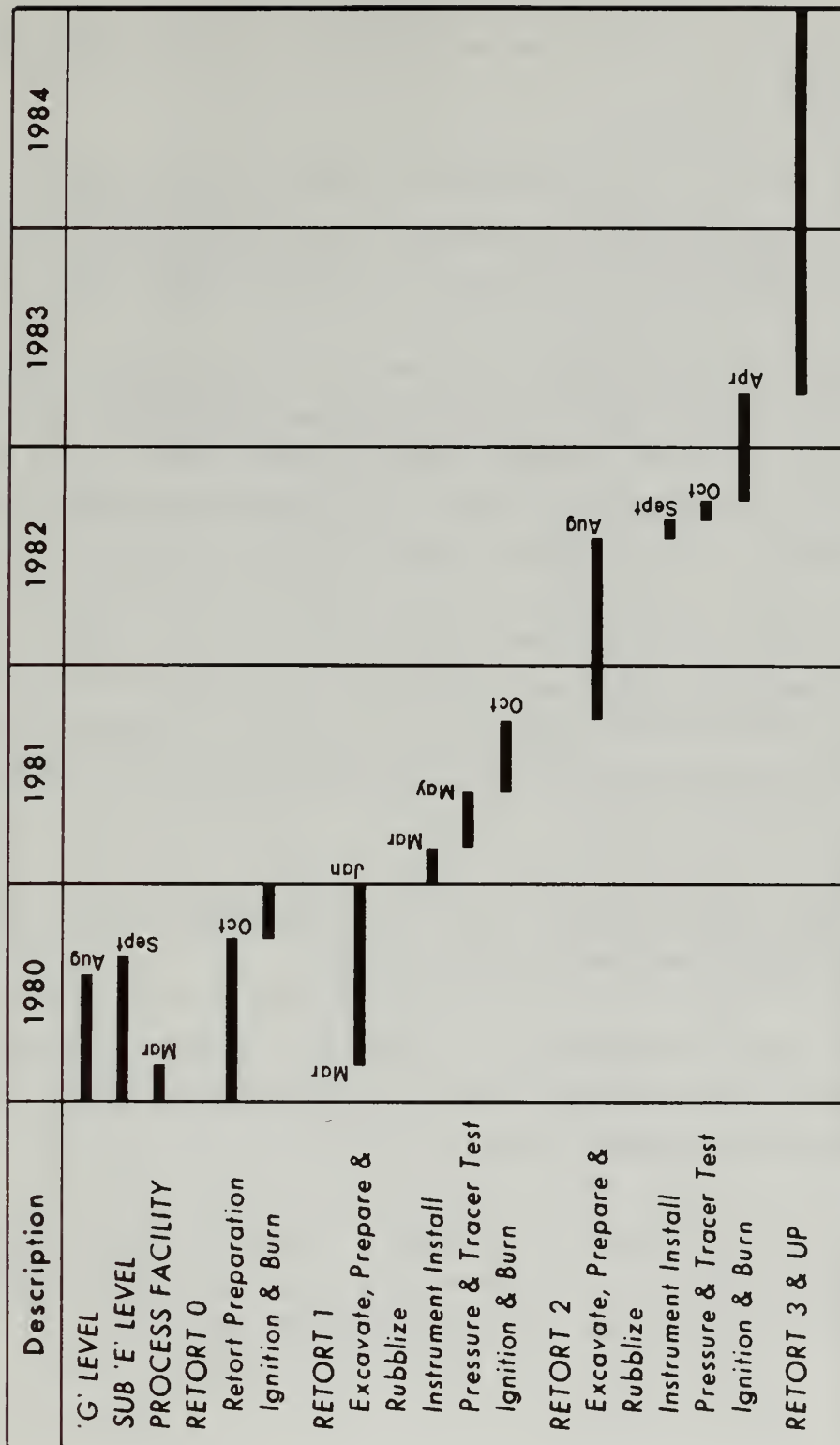


FIGURE 1-2-2
RBOSC MDP SCHEDULE

2.2 TRACT ACTIVITIES, JANUARY 1980 - DECEMBER 1980

Table 1-2-1 is a summary of the 1980 construction milestones for Tract C-a.

Table 1-2-2 is a list of RBOSC's major contractors and their responsibilities for work on Tract C-a.

Outfitting the service production shaft was completed during January allowing full scale drifting operations to commence. All drifting work on G-Level and Sub-E-Level was completed during 1980 and is shown in Figure 1-2-3.

The 10' diameter service escape shaft was upreamed in March, 1980. This shaft was intended to be used as a secondary man access and service route, however, problems with the patented braking system on the single deck cage have restricted utilization of this shaft as an escape shaft only. The shaft is currently equipped with a four-man cage running on rope guides.

The five foot diameter off-gas shaft was upreamed in April 1980. A 48-inch steel liner cemented in place was installed in the shaft in May, 1980. The main purpose of the liner is to stop all ground water from entering the shaft during retorting operations since this water would end up in the sour water system.

The 8' diameter instrumentation shaft, including station development for Retort One, was completed during December, 1980.

Drilling blast holes for Retort Zero was completed February, 1980 and rubblizing was completed in June, 1980. The retort was ignited October, 1980 and the burn completed in December, 1980.

Drilling blast holes for Retort One commenced in June, 1980 and was completed in October, 1980. Rubble draw from the retort was completed during the year and at year end rubblizing the retort was 75% complete.

TABLE 1-2-1

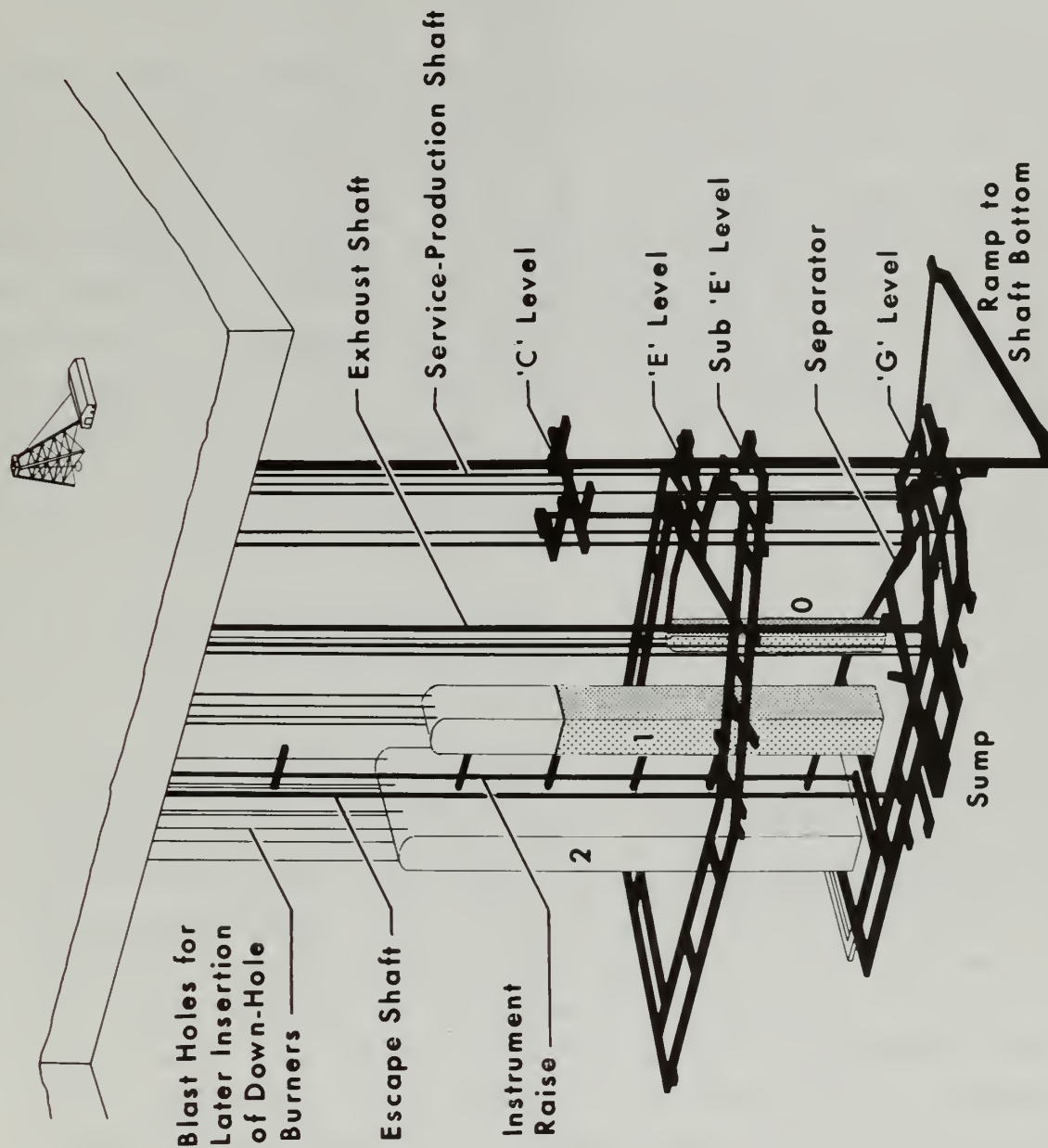
TRACT C-a CONSTRUCTION MILESTONES, 1980

	<u>Start</u>	<u>Completion</u>
Service/Production Shaft	April, 1978	January, 1980
Dewatering Well D-6 & D-7	January, 1980	January, 1980
Injection Well GS-20, GS-21	February, 1980	February, 1980
G-Level Excavation	March, 1979	August, 1980
Sub-E-Level Excavation	January, 1980	September, 1980
Dewatering Well Power Line (D6, 7, 8, 9)	March, 1980	April, 1980
Corral Gulch Dewatering/Injection Pipeline	November, 1979	January, 1980
Box Elder Gulch Dewatering/Injection Pipeline	February, 1980	April, 1980
50 Ton Ore Bin	December, 1979	January, 1980
Miners Change Room	January, 1980	February, 1980
Mining Warehouse	January, 1980	April, 1980
Retort Zero Blasthole Drilling	October, 1979	February, 1980
Phase I Evaporation Ponds	October, 1979	February, 1980
Phase II Evaporation Ponds	July, 1980	November, 1980
Off Gas Shaft Upreaming	March, 1980	April, 1980
Service Shaft	February, 1980	September, 1980
Instrumentation Shaft and Stations	April, 1980	December, 1980
Off Gas Shaft Liner	May, 1980	May, 1980
Hydrologic Monitoring Wells	March, 1980	April, 1980
Booster Pump Station (Box Elder)	April, 1980	September, 1980
Retort Zero Rubblization	May, 1980	June, 1980
Retort One Startup Piping	July, 1980	October, 1980
Airstrip Surfacing	August, 1980	September, 1980
Retort Zero Underground Bulkheads	August, 1980	September, 1980
Sub-E Longhole Drilling	August, 1980	October, 1980
Retort Zero Burn	October, 1980	December, 1980

TABLE 1-2-2

TRACT C-a MAJOR CONTRACTORS AND RESPONSIBILITIES, 1980

Contractor	Responsibility
Morrison-Knudsen Company (M-K)	Construction Management, Design Engineering, Quality Control and Administrative Functions
Mine, Shaft & Tunnel (MS&T)	Mine Development, Underground Construction, Operations and Maintenance
The Industrial Company (TIC)	General Services Contractor, Above Grade Construction for Processing Facility
Robinson and Son, Inc.	Evaporation Pond Construction (Phase I)
Construction Surveys	Site Survey
James Drilling Company	Dewatering Wells/Injection Wells
Cooper & Clark	Soils and Concrete Testing
White River Roustabouts	Fencing and Clearing
UPCO, LTD.	Power Line Dewatering Wells
Teton Exploration	Install Off-Gas Shaft Liner
Parker Air Drilling	Retort One Blasthole Drilling
D & R Drilling	Retort One Blasthole Drilling
Nielsons	Evaporation Ponds (Phase II)
Corn Construction	Air Strip Surfacing
Stair/Adair Insulation	Piping and Mechanical Insulation
Systems, Science & Software	Tracer Gas Measurement
A. R. Industrial	Instrument Shaft Hoist Electrics
Rippy Construction	Access Road - Lurgi Area
Wildcat Drilling Service	Borehole/Monitor Wells - Lurgi Area
XL Drilling	Borehole/Monitor Wells - Lurgi Area
Golder Associates	Soil Tests - Lurgi Disposal Area
Woodward Clyde Consultants	Soil Tests - Lurgi Plant Area
Morrison-Knusden Co., Inc.	Soil Tests - Lurgi Open Pit Area
Law Engineering & Testing	Hydrologic Tests - Lurgi Open Pit Area
Holleran Services	Lurgi Demonstration Project - Socio Economics



MDP Mine Development Progress Through 1980

FIGURE 1-2-3

MDP MINE DEVELOPMENT PROGRESS THROUGH DECEMBER 1980

During the year a second bank of ASH C-5 pumps and a bank of ASH D-5 pumps were installed on G-level, to provide capacity for an anticipated increase in mine water inflow associated with the accelerated dewatering on Sub-E-Level. Water inflow to the mine remained steady at 900 to 1000 gpm through July. As development on Sub-E-Level continued and longhole drilling progressed, water inflow to the mine increased to approximately 1300 gpm by year end.

The mine dewatering requirement for MIS is to intercept the ground water flows into the retort area and substantially eliminate water flows into the retorts. At the beginning of the year one dewatering well (D-5) was operable and four new dewatering wells, two new injection wells, and the associated electrics and piping were being constructed. Two of the four new dewatering wells were pump tested and abandoned as non-producers. The other two dewatering wells (D-6 and D-8) became operable during May, 1980. The two new injection wells were commissioned in September, 1980. At year end, one of the dewatering wells (D-5) near the mine was shut down because of lack of water. Indications are that the dewatering wells plus the longhole drilling from Sub-E-Level have reduced water inflow to Retort One in the order of 10 gpm.

The potable water plant was finally commissioned during 1980; eliminating the need to haul potable water from Meeker, Colorado.

At the beginning of the year the Processing Facility was essentially complete. Prior to Retort Zero ignition, the facility underwent vigorous testing and shakedown operations. Four evaporation ponds for sour water and scrubber blowdown water were finished during July, 1980. After further study, it was decided that additional ponds would be required. During July, 1980, a contractor was mobilized to construct three additional ponds. These ponds were designed to the same configuration as the first four. By year end, earthwork for the ponds was completed and the high grade laminated polymer-coated fabric liners were installed in all three ponds. Two of the ponds were tested and accepted prior to inclement weather stopping the work.

To reduce the volume of traffic on Piceance Creek Road and provide safer transportation, RBOSC implemented a bus transportation scheme. During the

year, four new 43-passenger buses were leased to provide employee transportation from both Rifle and Meeker. Employees residing in Rangely are also provided company vehicle transportation with vans and pickups.

The 84-Mesa Airstrip was upgraded during the year. The strip was lengthened, graveled and overlaid with hotmix asphalt.

Subsidence monitoring was performed twice during the year. No subsidence was measured from surveys of the subsidence monitoring network.

Environmental protection and health and safety programs continued to be implemented and refined during the year. Training programs were given to various personnel in the areas of mine safety and fire fighting. Safety meetings and indoctrinations were held with all contractors on a regularly scheduled basis. Dust control measures and revegetation were continued to mitigate air pollution problems.

During November and December, 1980, an access road was constructed to the future site of the surface retort north of Tract C-a. At year end the road was nearly completed to rough grade.

Figures 1-2-4, 1-2-5, and 1-2-6 are plot plans showing all existing structures or facilities either completed or under construction as of December 31, 1980 for the tract, the MDP Construction Area, and Processing Facility Area, respectively. Figure 1-2-7 is an aerial photograph of the main development area at Tract C-a. Table 1-2-3 is a legend identifying the major facilities completed during 1980.

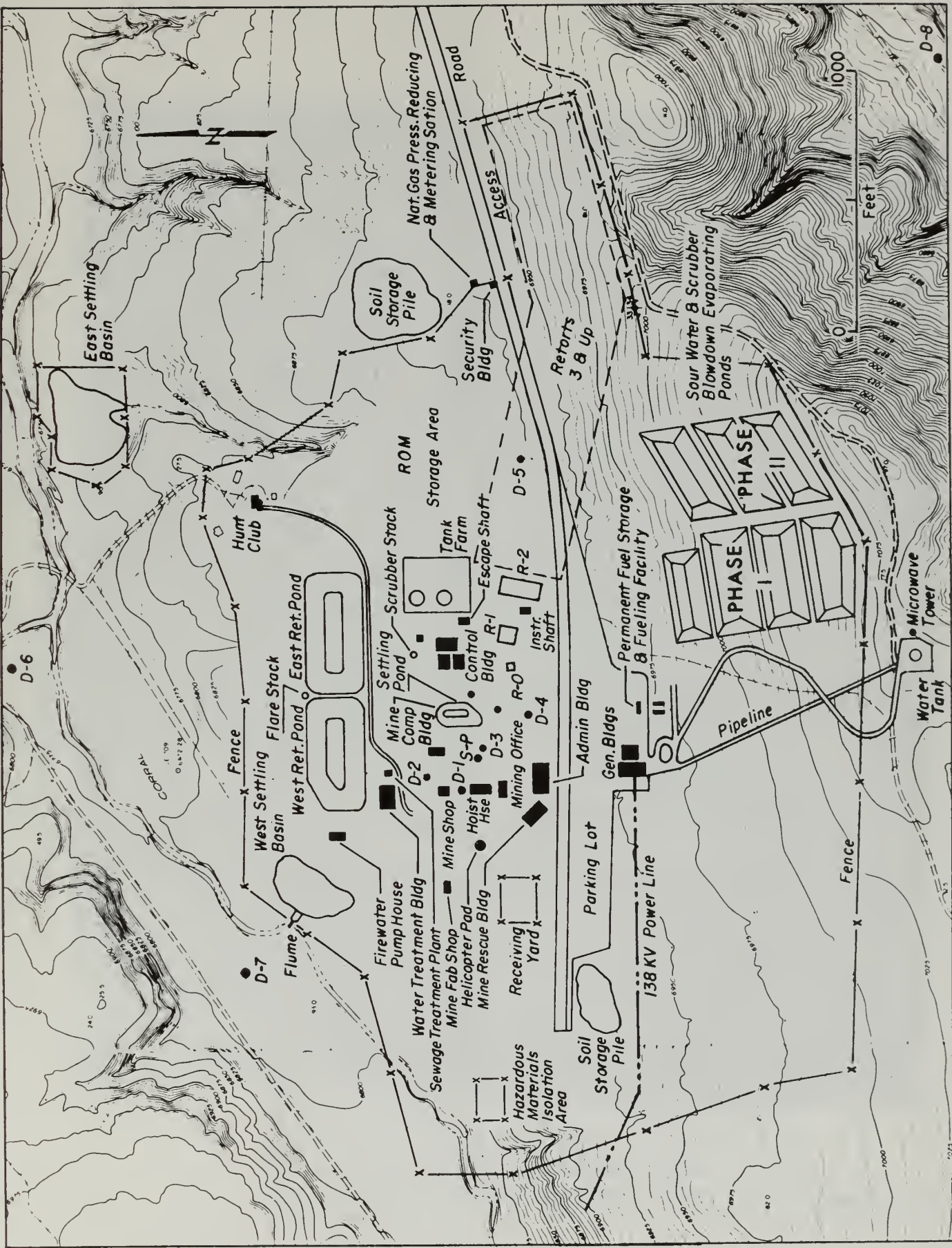


FIGURE 1-2-5
MDP CONSTRUCTION AREA, DECEMBER 1980

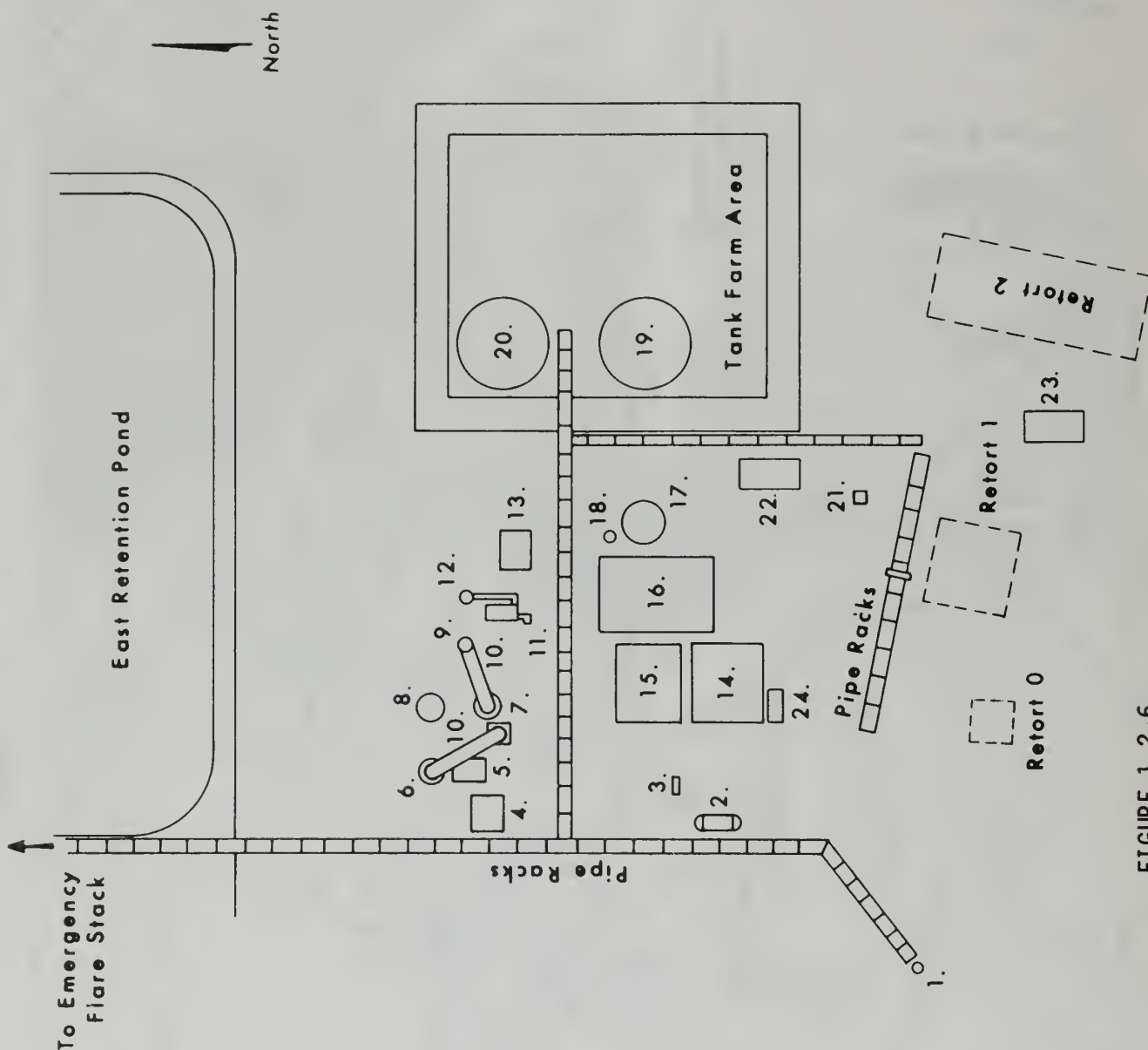


FIGURE 1-2-6
MDP PROCESSING FACILITY PLOT PLAN

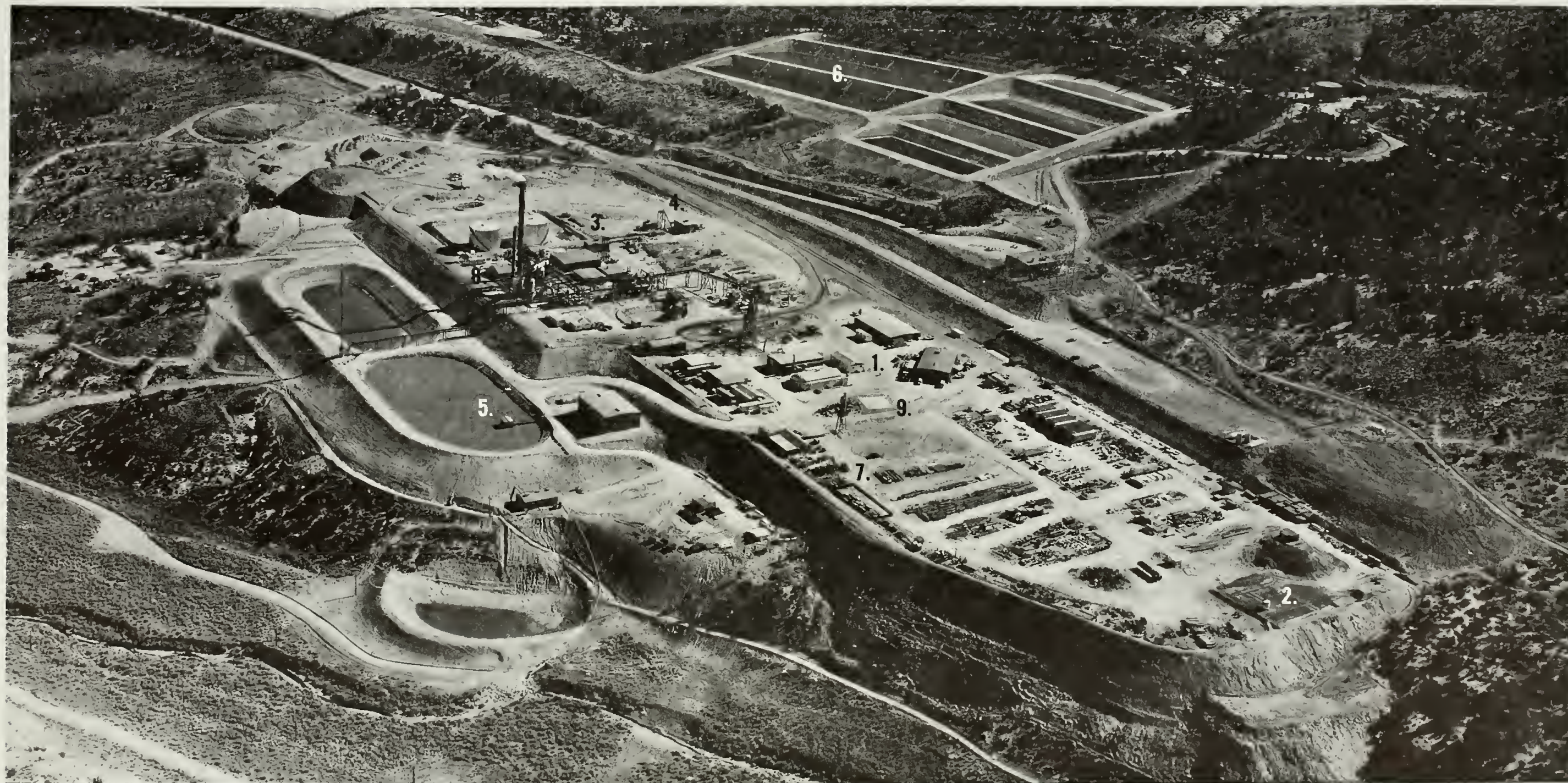


FIGURE 1-2-7
MDP CONSTRUCTION AREA OVERVIEW LOOKING S.E., NOVEMBER 1980

TABLE 1-2-3

LEGEND IDENTIFYING FACILITIES FOR FIGURE 1-2-7

1. Mining office building.
2. Hazardous materials staging area.
3. Service escape hoist building.
4. Instrument hoist and multiplexer building.
5. Floating process water pump station.
6. Evaporation pond (Phase II).
7. Five trailer Lurgi Demonstration Project office complex. (Started late November, 1980 and will be completed early 1981).
8. Process maintenance shops.
9. Helicopter pad.

2.3 SOCIOECONOMIC ACTIVITIES

Reports of socioeconomic plans and activities related to tract development are not required by the lease and are not included in the body of this report. However, because such activities are an integral portion of the Tract C-a effort, a brief summary is provided in this section.

The number of employees working on Tract C-a during 1980 ranged from 346 to 443. By year's end, the number was 382.

In December, 1980, approximately 82 percent of Tract C-a employees lived in the Rifle area, 14 percent in Meeker, and 3 percent in Rangely. About 1 percent stayed on Tract during the week; these were primarily people on call 24-hours-a-day. During the retort burn, key personnel stayed on site for several days at a time. These employees stayed in the newly installed bachelor housing, consisting of six 3-bedroom mobile home units.

Transportation is provided from Rifle, Meeker and Rangely via buses, vans and car pooling.

In November, 1980, Holleran Services, Inc., was contracted to develop a long range plan for mitigation of socio-economic impacts, primarily in the areas of housing and transportation for the Lurgi Demonstration Project.

Table 1-2-5 presents the actual monthly workforce for 1980. Figure 1-2-8 compares the actual and projected workforce figures for 1980 and the projection for 1981 (including the Lurgi Demonstration Project).

The differences between the actual workforce versus projected workforce can be attributed to early projections being made before the scope of work was completely known. Operating problems and schedule slippage associated with the gassy mine classification caused a higher peak workforce just prior to the ignition of Retort Zero in October.

Table 1-2-5

MAXIMUM MONTHLY WORKFORCE, TRACT C-a, 1980

<u>Month</u>	<u>Maximum Workforce</u>
January	353
February	351
March	346
April	351
May	354
June	371
July	388
August	439
September	443
October	427
November	390
December	382

Mobile Home Park, Rangely

RBOSC had for some time been attempting to stimulate construction of a mobile home park in Rangely by guaranteeing rentals. The developer experienced delays in permitting, etc., but the park was completed and approved for occupancy in the fall of 1980. By year's end, there were 22 mobile homes in the park.

Tract C-a to Rangely Road

The 1980 Colorado General Assembly's long bill provided \$2.0 million from the Oil Shale Trust Fund for initiation of construction of the road to Rangely, but when Rio Blanco County applied to BLM for approval of the revised right-of-way at the eastern end, BLM had problems with it. Therefore the County was unable to go to bid on that portion in 1980, though efforts were pursued to resolve the right-of-way issue.

2.4 REGULATORY REQUIREMENTS

All major permits and approvals to allow construction and operation for the MIS demonstration had previously been obtained. Other approvals, variances,

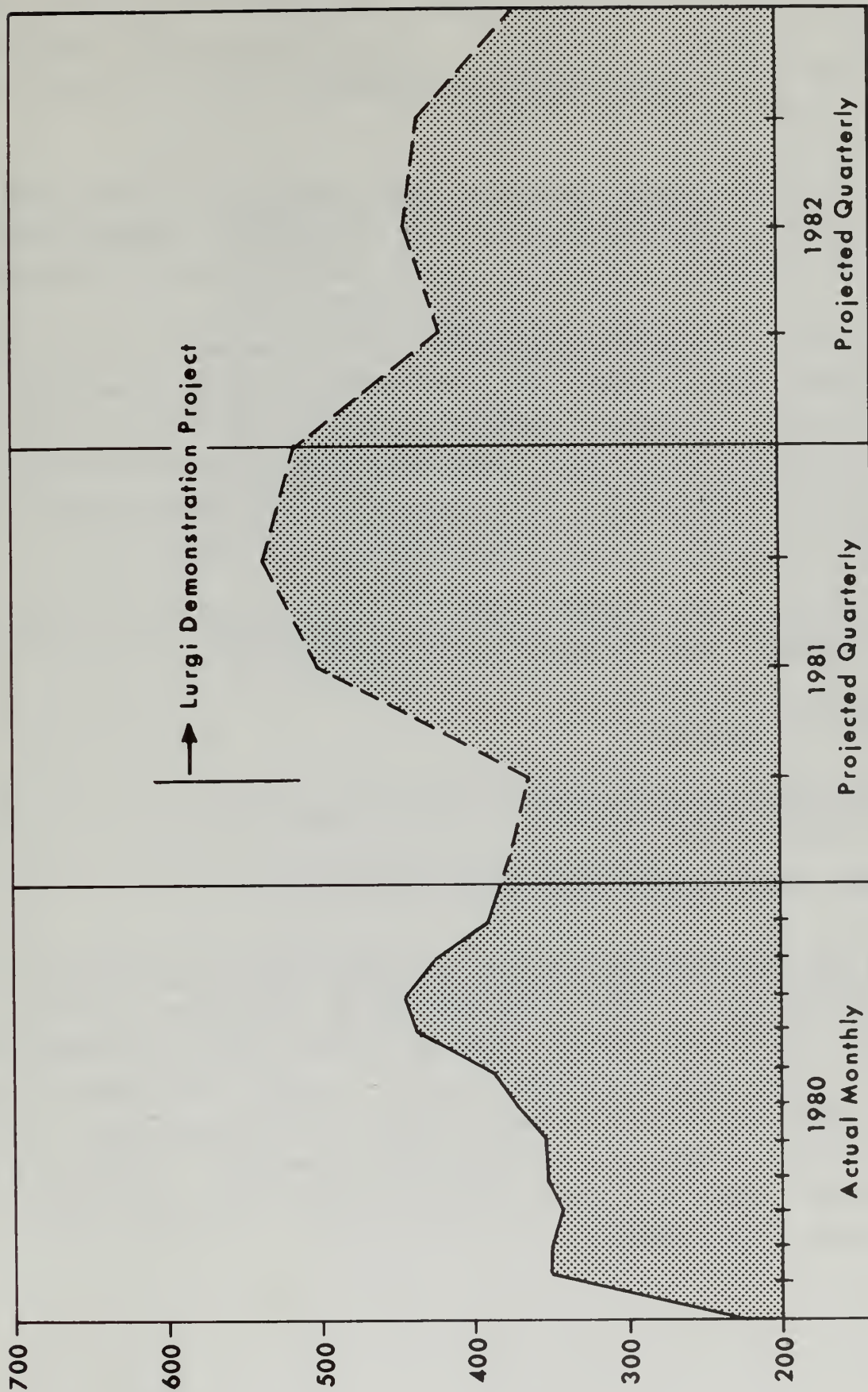


FIGURE 1-2-8
TRACT C-a WORKFORCE
RBOSC AND CONTRACTORS

right-of-ways, etc. to allow continued construction and operation were obtained as required. Permitting for the Lurgi Demonstration Project was begun. The significant permitting work related to 1980 Tract C-a activities were as follows:

- Rio Blanco County Special Use Permit was obtained in March 1980 to install six mobile homes on Tract as a bachelor emergency quarters for technical specialists, loanee supervisors and key personnel.
- Lurgi - The Colorado Historical Society confirmed that the Lurgi Demonstration Project area had previously been archaeologically cleared. In addition, approval was obtained from the OSO and permits obtained from the Colorado Department of Health Air Pollution Control Division and Colorado Mined Land Reclamation to build an access road from the tract entrance to the Lurgi processing area.
- General - An ammended right-of-way was obtained from the BLM to lengthen, widen and pave the Tract C-a airstrip.

2.5 FINANCIAL INFORMATION

The 1980 Summary of Costs for RBOSC is given in Table 1-2-4.

2.6 ANNUAL PROGRESS REPORT (APR) ORGANIZATION AND USE

RBOSC's APR was written and organized to closely follow the organization of the first APR which in turn corresponded to the organization of the DDP of May 1977. All section titles of the APR are the same as the DDP except Section 7 which combines Sections 7 and 8 of the DDP. By referencing the section number and title, the reader can refer to the previous APR or the DDP for additional information on the plan being implemented. If no new work in a particular subject area was done during the year, the related chapter is not included in this report.

TABLE 1-2-4

RBOSC SUMMARY OF COSTS - 1980
(\$000)

<u>Engineering, Construction and Development</u>	
Dewatering	1,248
Site Work	534
Power Plant	302
Processing Facility	1,441
Shaft, Hoist and Headframe	147
Mine Services	13,978
Drifting, Retorting	6,755
Operations	6,951
Managing Contractor Services	2,222
Technological Design	5,187
Environmental	283
Other	1,488
Lurgi Project - Phase I	<u>4,102</u>
Total Development	\$44,647
<u>Administrative</u>	<u>\$ 3,633</u>
Total C-a Project	<u><u>\$48,280</u></u>

The DDP presented RBOSC's plan of action. The previous progress reports told what had occurred on Tract C-a since operations commenced after approval through the end of 1979. This report covers progress for 1980.

A three-digit page numbering system is used throughout the APR. Page numbers are keyed to the chapters within the section; page 5-3-4, for example, refers to Section 5, Chapter 3, page 4. A similar system is used for figure and table numbers.

SECTION II

MINING

CHAPTER 1

INTRODUCTION

During 1980, the MDP mine was developed in preparation for the MIS retorting demonstration. The mine design and layout was modified slightly to accommodate conditions encountered during mine development. Underground construction for product collection and Retort Zero isolation was completed and Retort Zero was burned. Three additional shafts were bored as part of the development program.

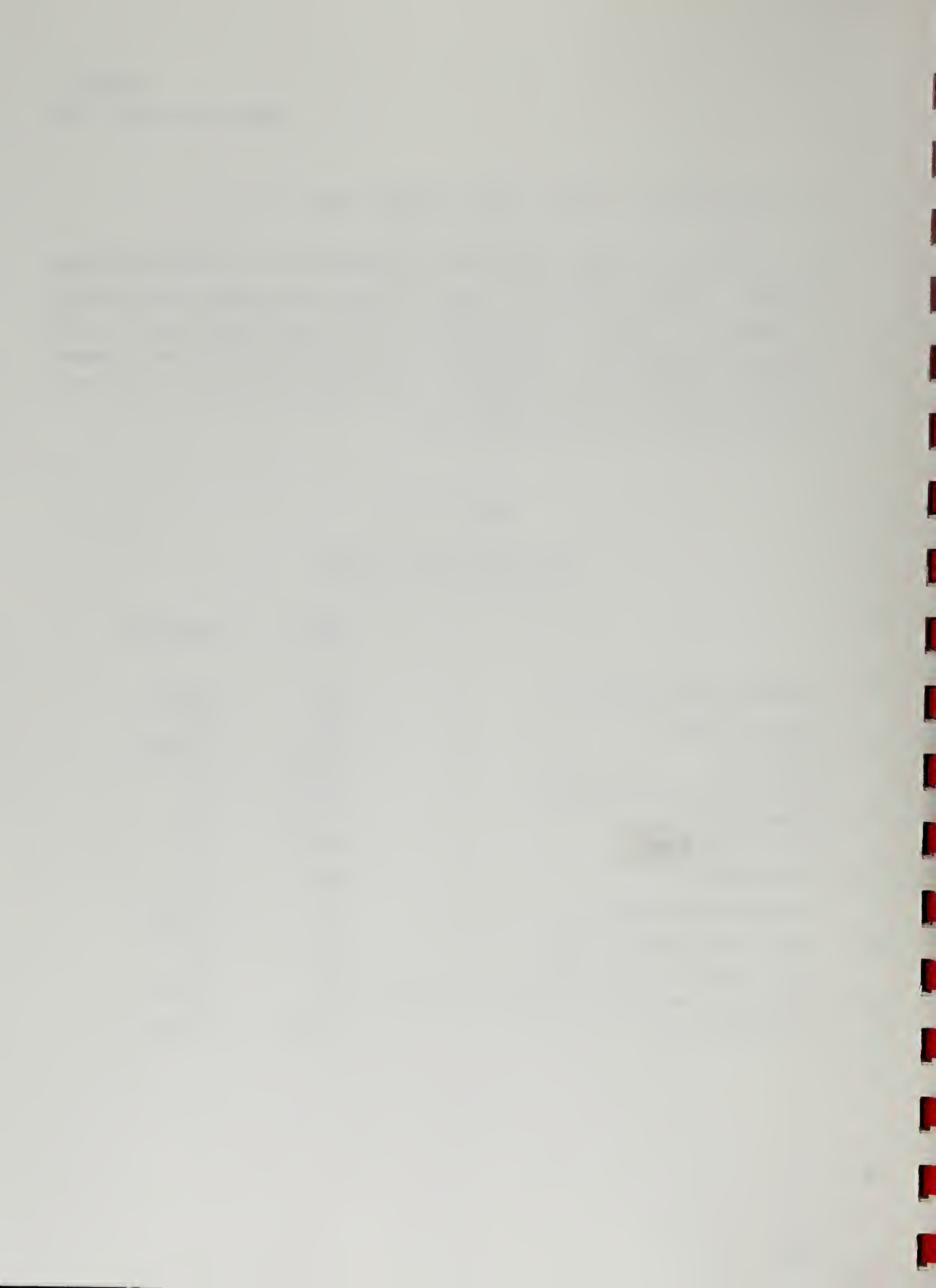
2.1 MINE ACTIVITIES - January, 1980 - December, 1980

Mine activities for 1980 started with the completion of the production shaft equipping. G-Level drifting for sump and retort development continued and was completed. Sub-E-Level was developed and longhole drilling for retort dewatering was completed. Three shafts were bored and constructed in preparation for the retort burn. Retort One rubblizing was started. Table 2-2-1 shows the major mining milestones for 1980.

TABLE 2-2-1

MINING MILESTONES - 1980

	<u>Start</u>	<u>Completion</u>
Production Shaft Equipping	1979	January
G-Level Driftwork	1979	August
Sub-E-Level	January	September
Retort Zero Drill & Rubblize	January	July
Escape Shaft	February	April
Shaft Bottom Ramp	March	July
Off-Gas Shaft	April	June
Instrumentation Shaft	May	December
Sub-E-Level Dewater Drilling	June	December
Drill & Rubblize Retort One	July	1981
Retort Zero and Product Collection Facilities	May	October
Burn Retort Zero	October	December



The basic MDP mine design presented in 1979 was implemented. Modifications were made during mine development to mitigate problems or conditions encountered. The changes made include the relocation of explosives magazine, addition of a ramp to the bottom of the production shaft, and refinements to the retort rubblization technique.

The current design for G, Sub-E, and C & E-Levels are shown in Figures 2-3-1, 2-3-2 and 2-3-3 respectively. The basic ventilation structures and air flow patterns are included on these drawings.

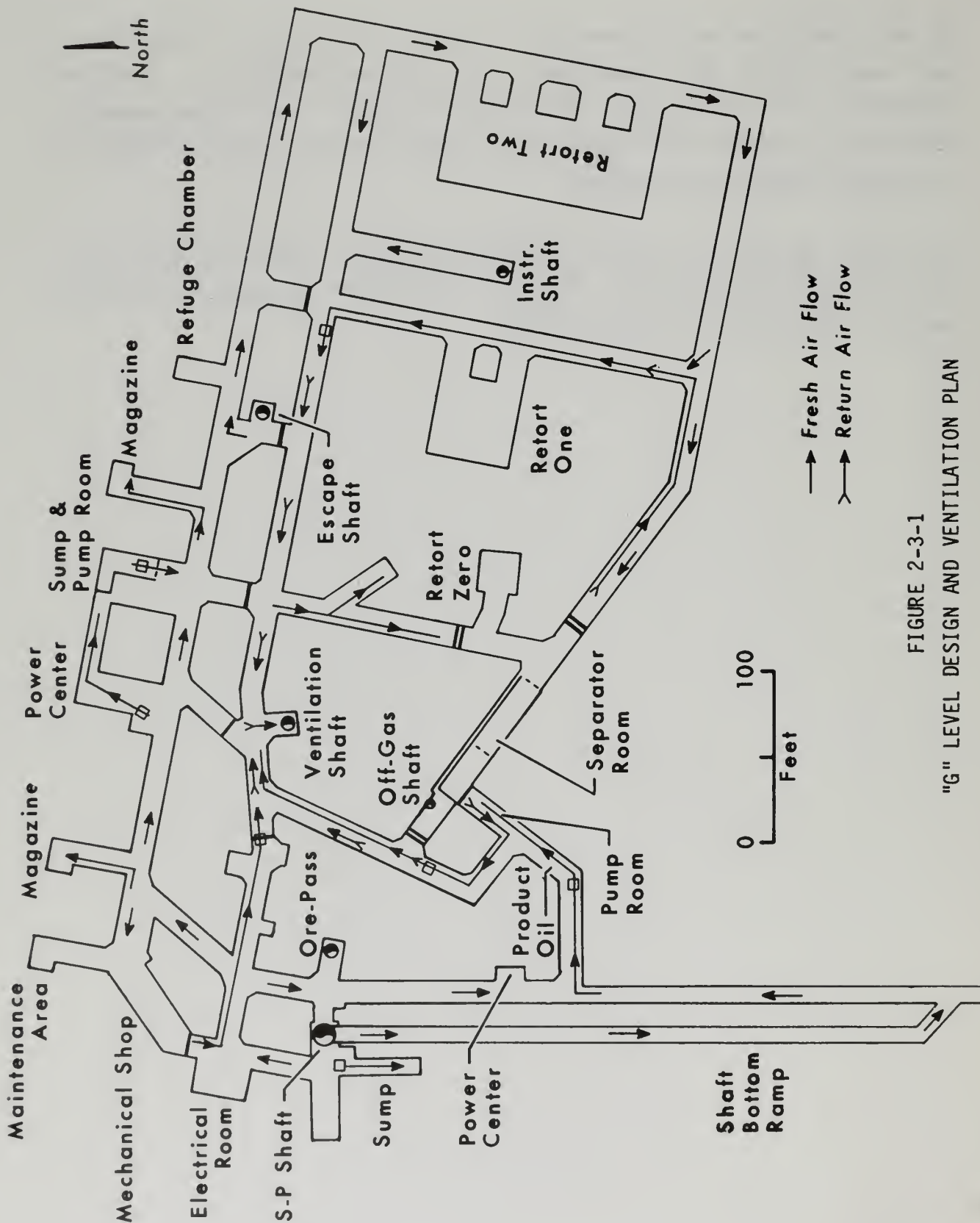


FIGURE 2-3-1
"G" LEVEL DESIGN AND VENTILATION PLAN

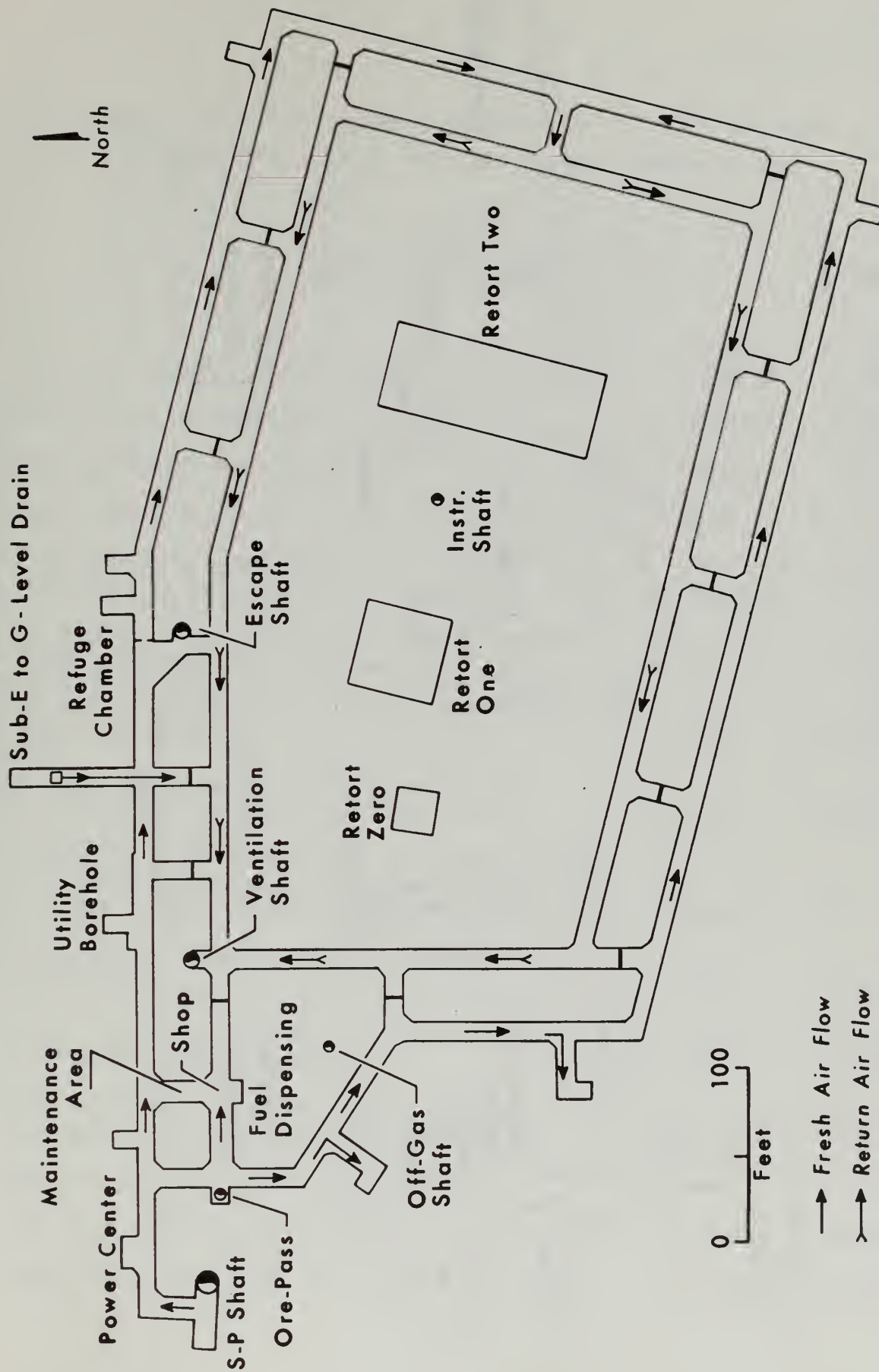


FIGURE 2-3-2
SUB-E-LEVEL DESIGN AND VENTILATION PLAN

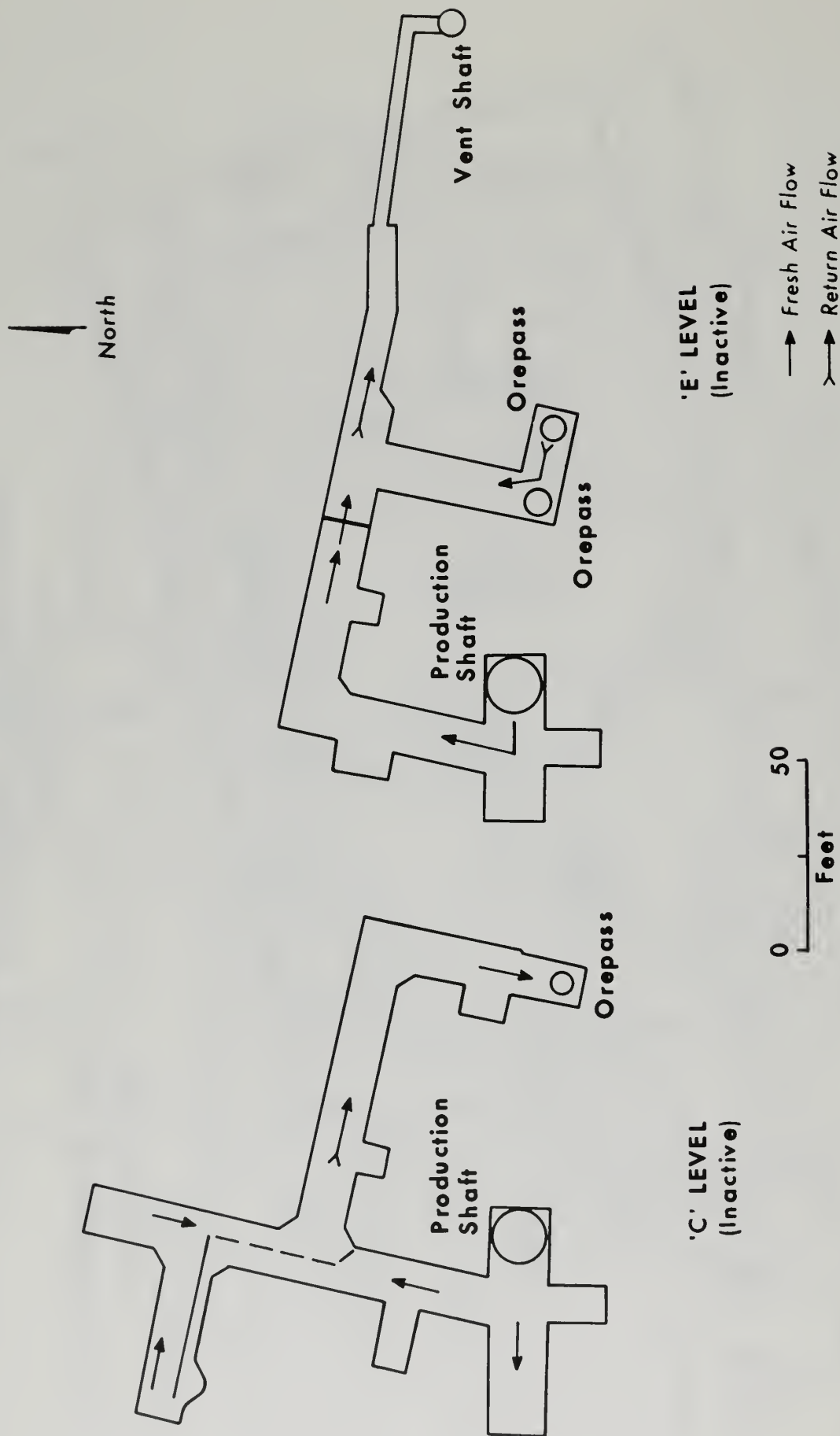


FIGURE 2-3-3
"C" AND "E" LEVEL DESIGN AND VENTILATION PLAN

Mine development for the MDP was completed up to the rubblizing of Retort One. The following list outlines the major accomplishments of 1980:

TABLE 2-4-1
MAJOR ACCOMPLISHMENTS OF 1980

<u>Accomplishment</u>	<u>Start 1980</u>	<u>Completed 1980</u>
G-Level drifting completed.	January	August
Sub-E-Level drifting completed.	January	September
Ramp from G-Level to bottom of production shaft.	March	July
Upreamed and equipped 10-foot diameter, 840-foot deep service/escape shaft.	February	April
Upreamed and supported 8-foot diameter, 840-foot deep instrumentation shaft.	May	June
Upreamed and cased the 5-foot diameter, 860-foot deep off-gas shaft.	April	June
Upreamed and cased the 2-foot diameter water transfer hole between G and Sub-E-Levels.	June	July
Drilled and cased 12 boreholes for power, instrumentation, pump discharge, and auxilliary service functions from surface to G-level.	January	July
Completed the longhole drilling program on Sub-E-Level.	June	December
Constructed and commissioned the main mine dewatering sump on G-level.	May	September
Constructed and installed the underground product collection and pumping facilities.	May	September
Rubblized and isolated Retort Zero.	April	October
Rubblized 75% of Retort One.	November	December
Mined 6 stations off the instrumentation shaft.	November	December

All of the development work was done by Mine, Shaft and Tunnel Corp. with the exception of retort blast hole drilling which was done by three different drilling companies. Mine development progress for 1980 is shown on Figures 2-4-1, 2-4-2 and 2-4-3. The material mined during 1980 is shown in Table 2-4-2.

TABLE 2-4-2
MATERIAL MINED - 1980

<u>ITEM</u>	<u>SIZE</u>	<u>Lineal Feet</u>	<u>TONS</u>
Drifting			
G-Level	10x16	3,995	57,500
Sub-E-Level	10x12	4,805	38,440
E-Level	6x6	90	220
Instrument Station	10x16	330	3,520
Shafts			
Escape	10' O.D.	840	4,400
Instrument	8' O.D.	840	2,820
Off-Gas	5' O.D.	860	1,130
Rubble Draw			
Retort Zero			1,580
Retort One			11,500

4.1 SUPPORT OPERATIONS

A. Ventilation - The mine is ventilated using an 8-foot diameter, 300 hp., Jeffrey fan to exhaust air at about 220,000 cfm. During drifting operations, auxiliary fans ranging from 7.5 to 60 hp. were used to ventilate the headings. Figures 2-3-1, 2-3-2 and 2-3-3 show the ventilation system as it was configured at yearend.

B. Mine Gases - The mine was operated under the gassy classification (MSHA) all year. This requires rigorous ventilation and monitoring to maintain methane concentration well below the explosive limit at all times. Special MSHA approved "permissible" equipment is required in the working area. Methane occurs principally on G-Level, but was not encountered in hazardous quantities in the working areas. In addition to the explosion hazard of

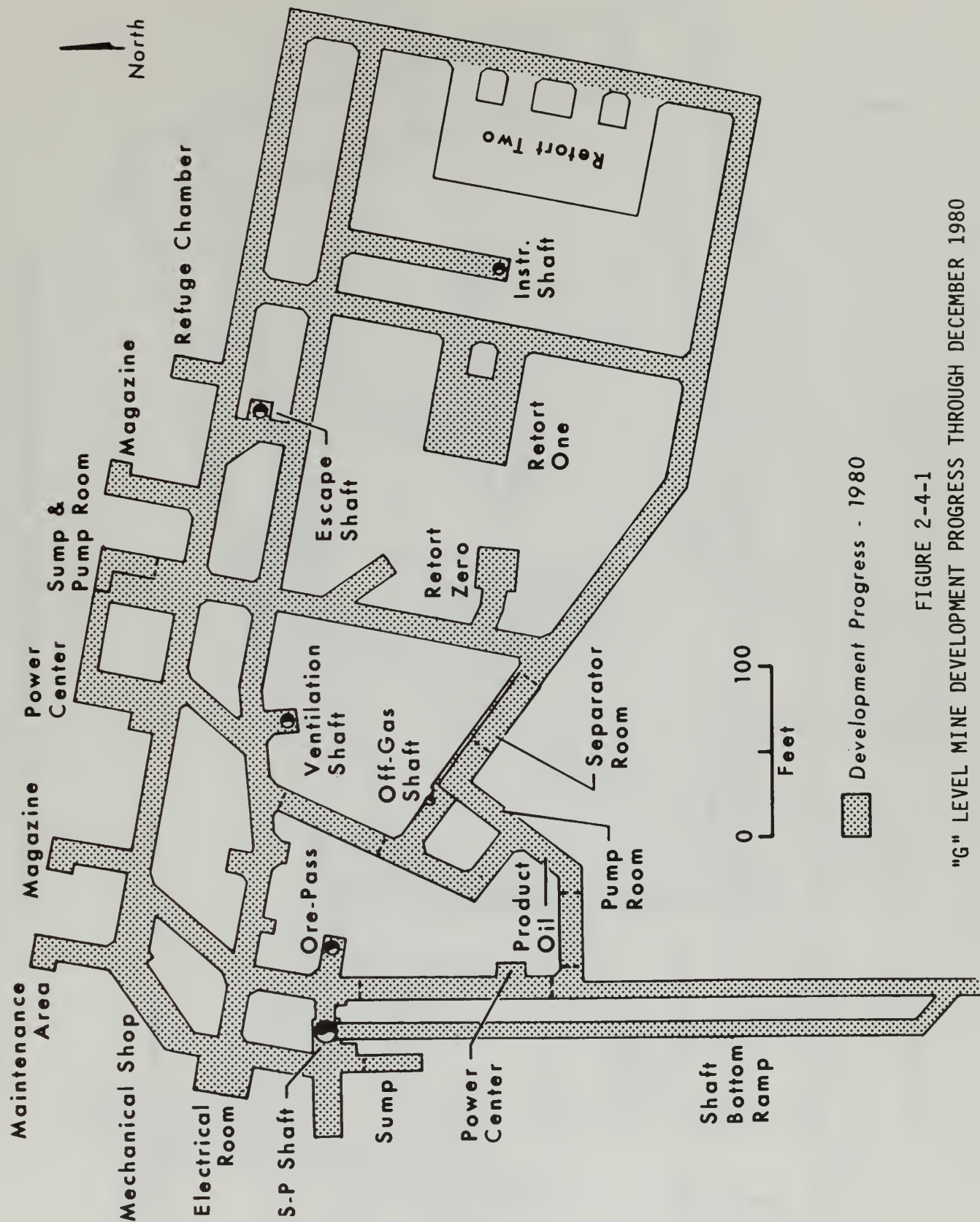


FIGURE 2-4-1
"G" LEVEL MINE DEVELOPMENT PROGRESS THROUGH DECEMBER 1980

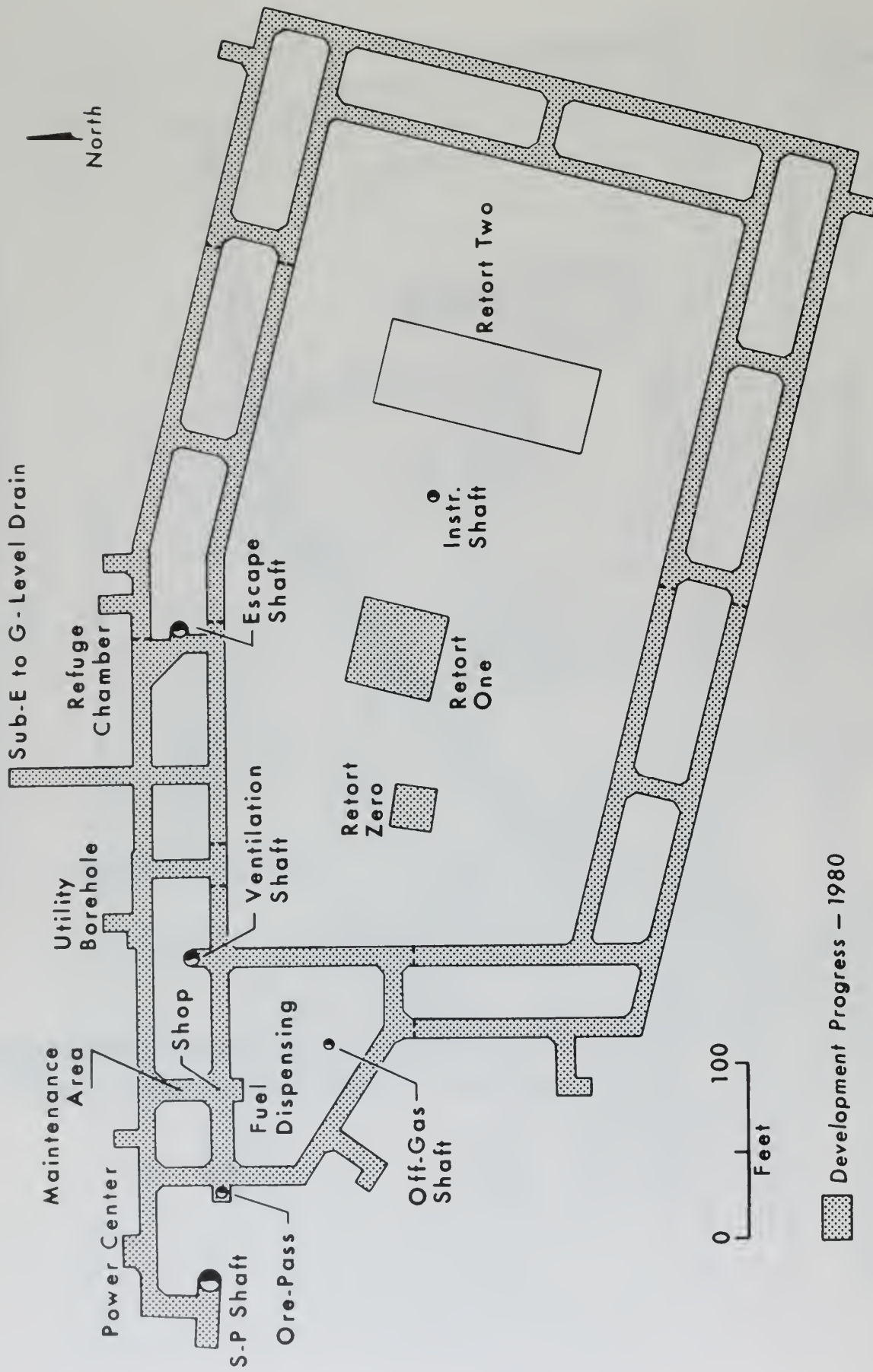


FIGURE 2-4-2
SUB "E" LEVEL MINE DEVELOPMENT PROGRESS THROUGH 1980

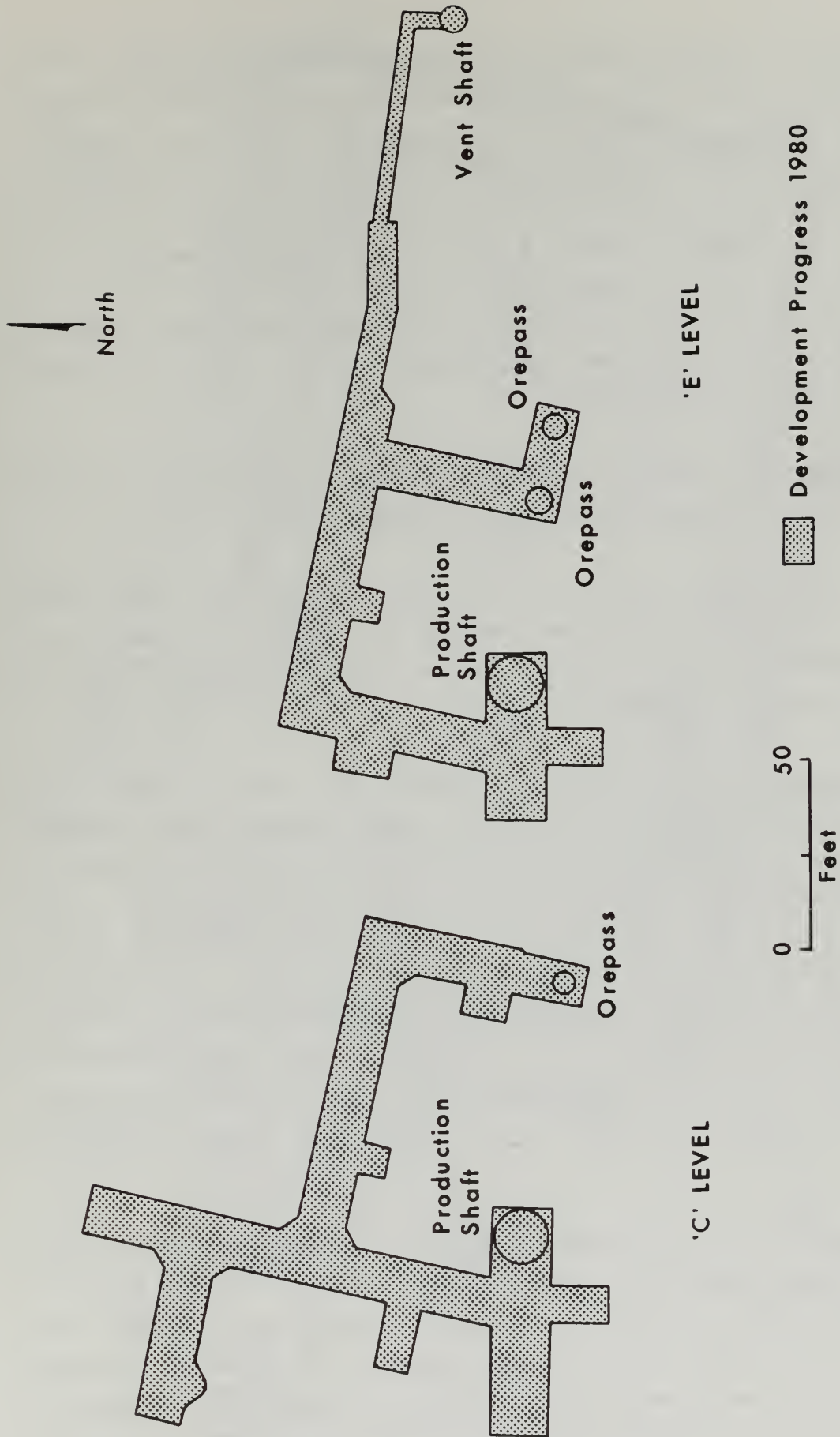


FIGURE 2-4-3
 "C" AND "E" LEVEL MINE DEVELOPMENT PROGRESS THROUGH 1980

methane, the mine atmosphere may contain hydrogen sulfide. Hydrogen sulfide occurs primarily on Sub-E-Level because the gas is associated with the ground water. It liberates quite rapidly upon discharge into the mine openings. For this reason most of the water from the long hole drilling program was piped into the return air course where the liberated H₂S was exhausted directly to the surface. Levels as high as 15 ppm were measured in the return air course but safe levels (below 10 ppm) were maintained in all work areas. Carbon monoxide is generated by diesel powered equipment operations and blasting. No problems were encountered as long as the ventilation circuits were properly maintained.

C. Ground Control - Split set roof bolts on about 4-foot centers and steel mats were used as the primary roof support throughout the mine.

Steel sets were used on Sub-E-Level to control the roof in two areas where a thin bedded incompetent zone was encountered. The location of these areas is shown on Figure 2-4-4. The location of steel sets previously installed on E-level are shown on Figure 2-4-5.

D. Mine Drainage - Sub-E-Level was developed and serves as the primary dewatering area for the mine. Approximately 90% of the 1400 gpm being pumped from the mine is collected on Sub-E-Level through a series of longholes. Figure 2-4-6 shows a typical manifold system used to collect the water at the long holes. This water is collected and dropped directly to the G-level ASH 2 sump through a 24-inch diameter borehole. Figure 2-4-7 shows the Parshall measuring flume at the top of the Sub-E to G-level 24-inch borehole. The ASH 2 pump station is made up of a bank of 3 ASH C5 pumps rated at 1700 gpm and a bank of 2 ASH D5 pumps rated at 3500 gpm. The ASH 1 pump station which serves as the backup system is rated at 1700 gpm. E-level has dried up completely.

E. Mine Power - Two 4160 volt feeders have been run down separate cased bore holes to G-level. The first feeder provides power for Sub-E-Level and all general uses on G-level, while the #2 feeder is dedicated to the ASH 2 pump station. The two feeders can be looped manually in case of an emergency. However, in the normal operating mode they are independent of one another. This is mandated by an Mine Safety and Health Administration (MSHA) variance

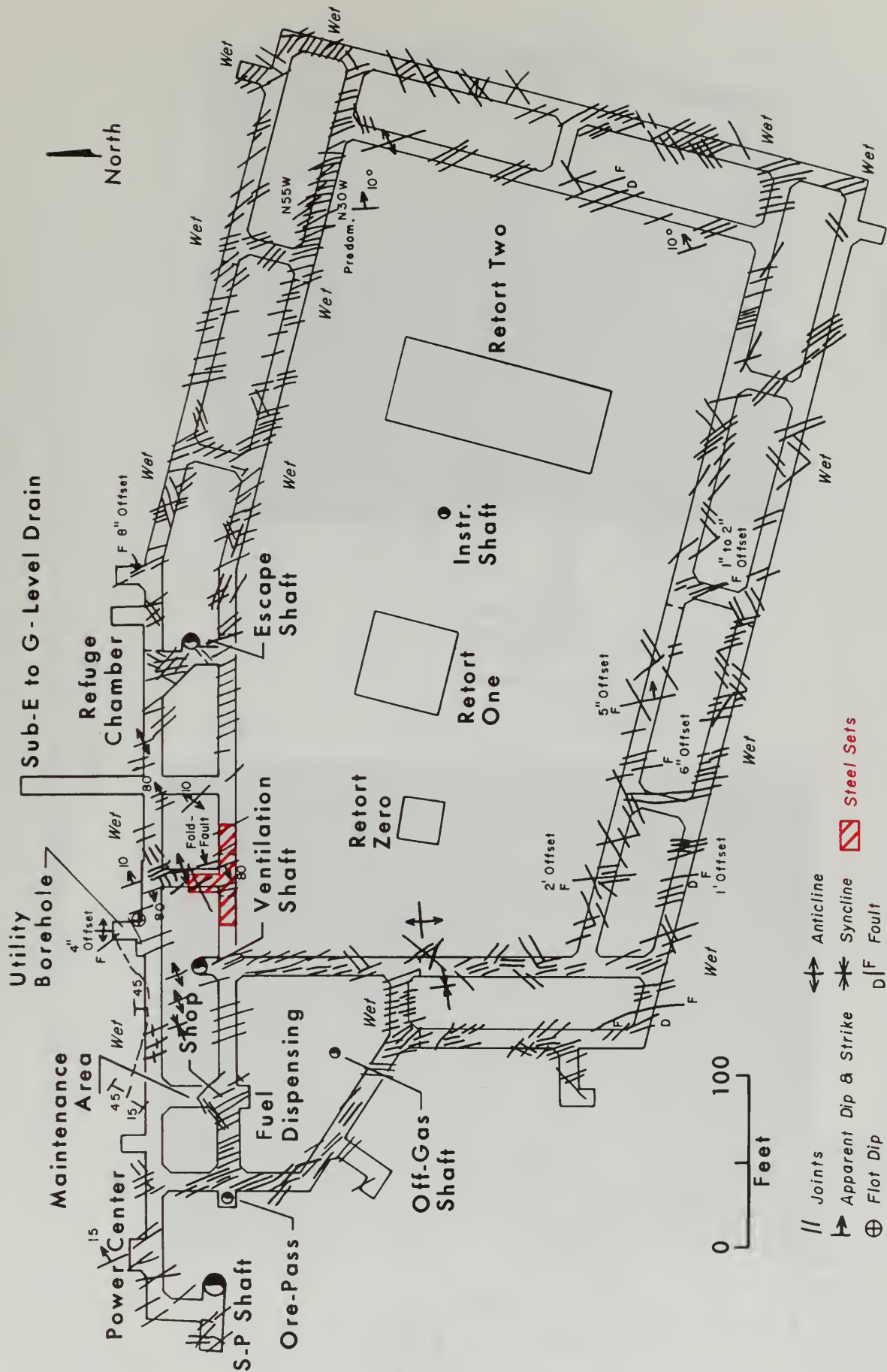
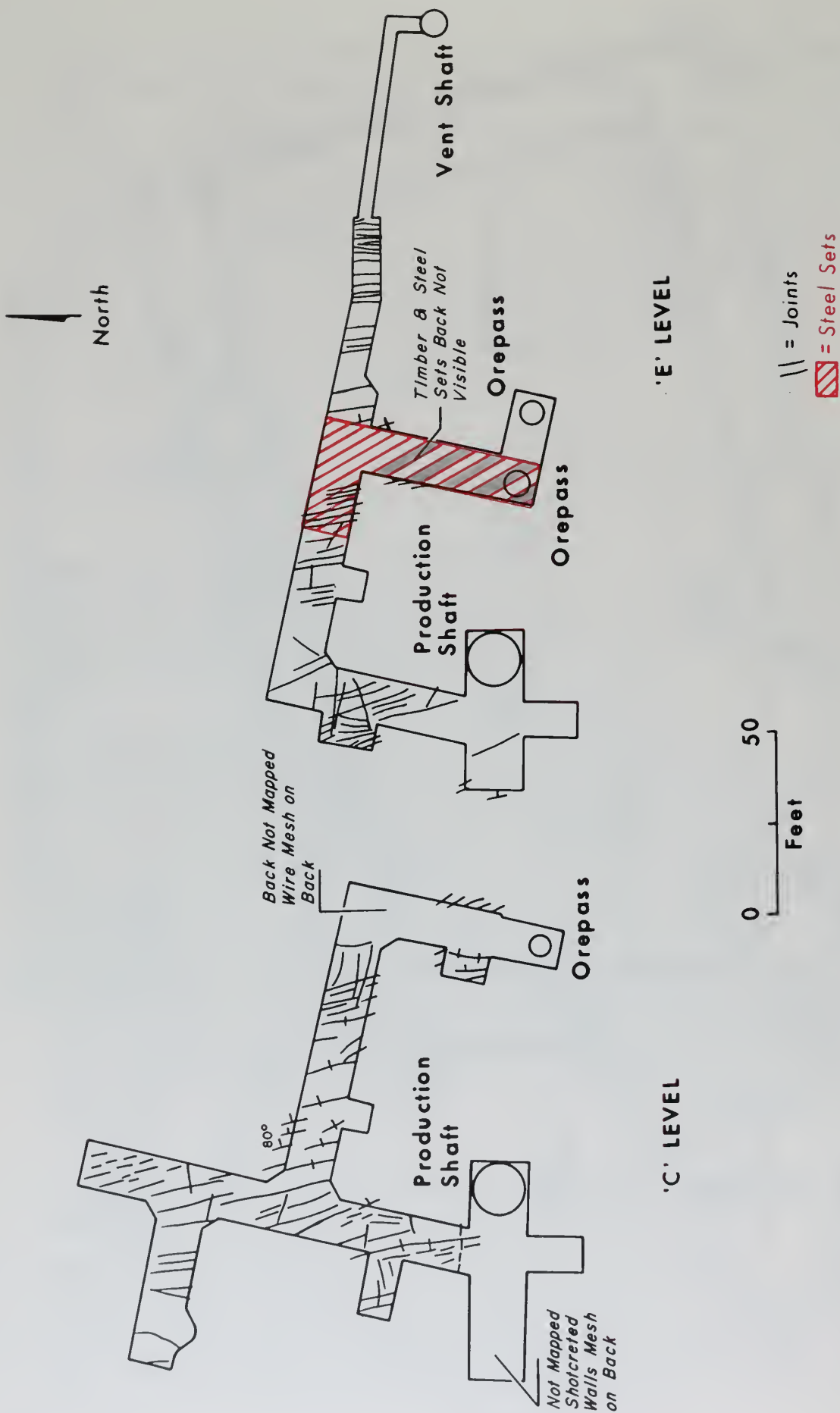


FIGURE 2-4-4

SUB "E" LEVEL GROUND CONTROL AND GEOLOGIC STRUCTURAL FEATURES



2-4-8

FIGURE 2-4-5
 "C" AND "E" LEVEL GROUND CONTROL AND GEOLOGIC STRUCTURAL FEATURES



FIGURE 2-4-6
MANIFOLD SYSTEM
SUB-E-LEVEL DEWATERING HOLES



FIGURE 2-4-7
PARSHALL FLUME ON SUB-E-LEVEL

which requires a separate feeder from the surface for the pumps and continuous methane monitoring with automatic de-energizing of the circuit at 0.8% CH₄.

A 1000 KW emergency generator has been installed to start automatically, providing power to operate the standby fan and escape hoist along with critical process plant equipment in case of a failure on the utility power system. A 2,500 KW O'Brien diesel generator is also available to provide standby power for normal hoisting, ventilation and pumping operations, in case of a sustained power line interruption.

F. Retort Facilities - The product collection, separation and pumping facilities were constructed for the MIS retorts. Bulkheads were installed to isolate the collection/separation system. The drifts were insulated and sealed. Four pumps were installed to pump the oil and sour water to the surface. Figure 2-4-8 shows the pumps in the product pump room.

G. Geology - Mapping of joints, flexures and faults has been virtually completed in the various mine levels and in the Service Production and Service Escape Shafts. Correlation to surface structural and photo linear strikes is excellent. The predominant direction of jointing is northwest. Prominent joints occur in belts of closely spaced fractures. These belts correspond to regional joint sets. Several fracture zones, areas of ground control problems, and increased water volume inflow correspond to surface photo linear patterns. Small lineal flexures varying in intensity tend to occur in all mine levels and in some areas correspond to increased jointing. The general orientation of the geologic structural features is shown in Figures 2-4-4, 2-4-5 and 2-4-9.

Fracture porosity is not uniform and mine water inflow tends to increase in zones of more closely-spaced fracturing and in certain zones of flexuring. Flexuring and minor faulting are more predominate at Sub-E-Level probably due to the stratigraphic change from competent to incompetent bedding in the zone transition from the R-6 to the L-5. Flexure and fault lineation in Sub-E level generally coincide with prominent jointing. In contrast flexures found

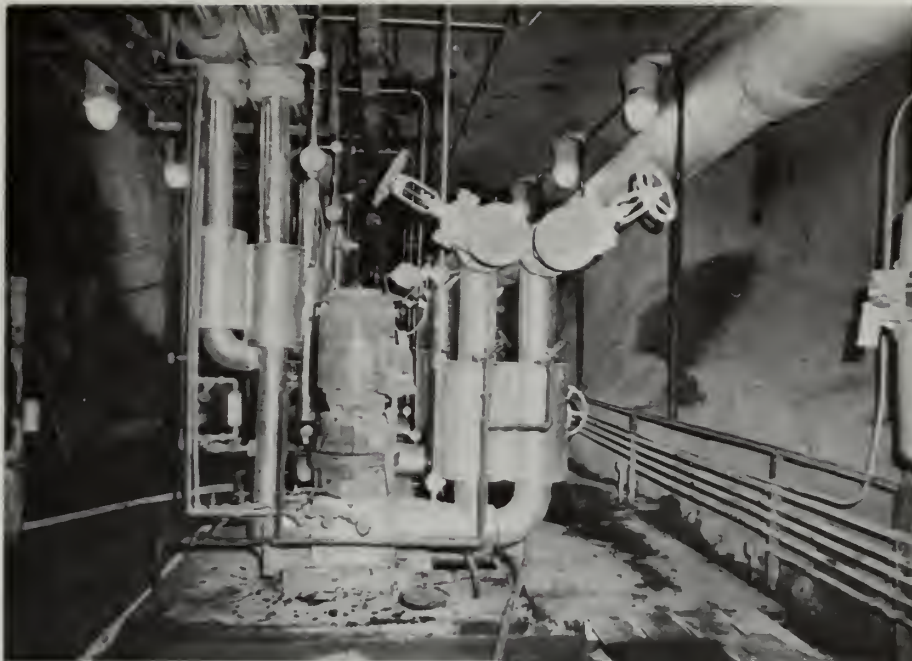


FIGURE 2-4-8
PUMPS - PRODUCT PUMP ROOM

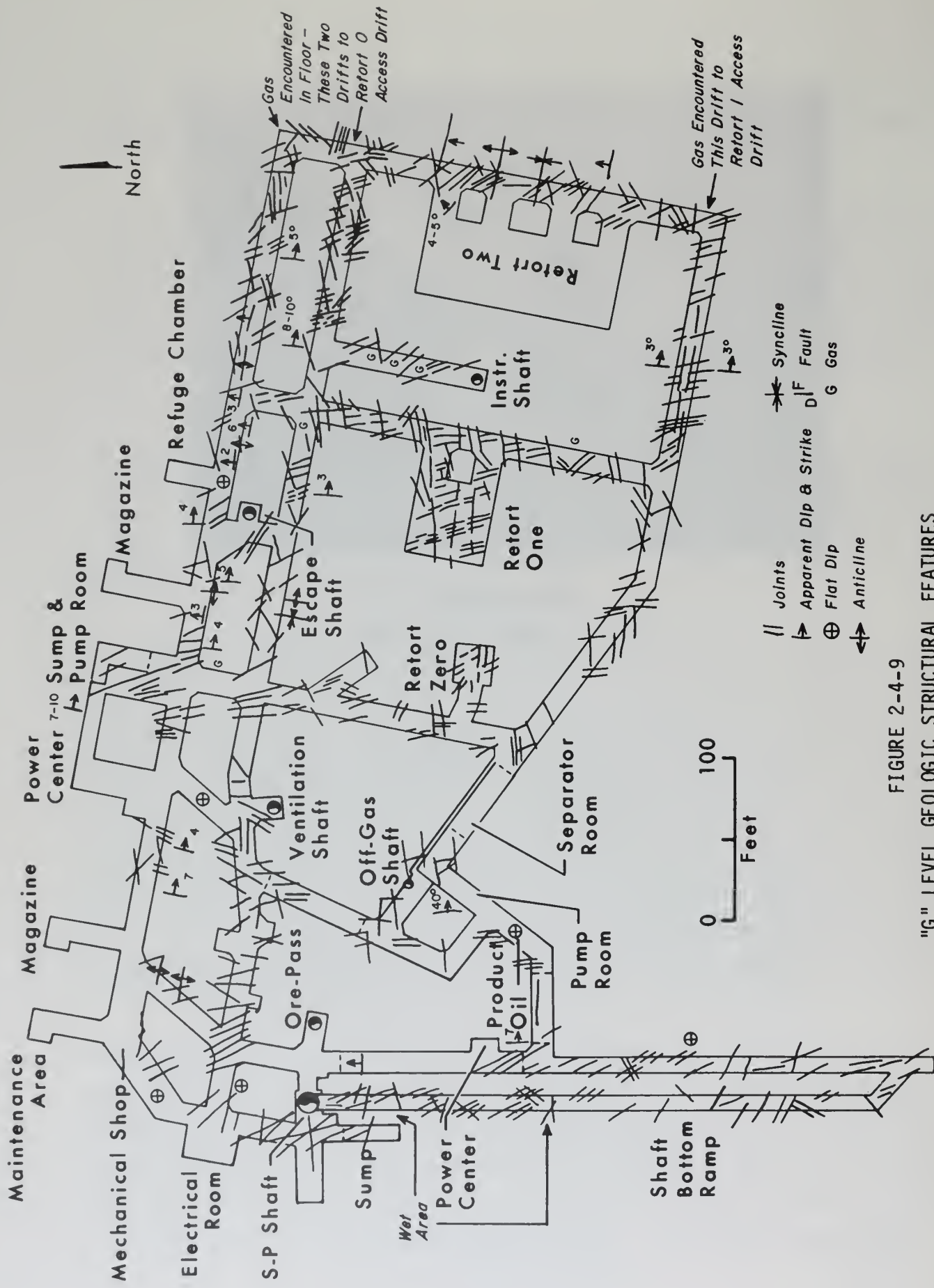


FIGURE 2-4-9
"G" LEVEL GEOLOGIC STRUCTURAL FEATURES

on G-level trend East-West and N15W, and are much more open and gentle monoclinical structures.

According to the United States Geological Survey personnel, methane gas encountered on G-Level in the floor and walls is likely to be related to a particular strata of the R-5 Zone of the oil shale sequence. However release of the gas may occur along bedding planes and fractures. Northwest trending alignments of gas boils have been observed.

Ground control problems in each level of the mine are the result of the presence of closely spaced fractures, tight flexures, or faults. In Sub-E and G-Levels ground control problems have occurred as a result of a change in stratigraphy as the drift encounters incompetent strata.

4.2 MINE SAFETY

A. Mine Safety training and performance are shown in Section VI, Chapter 2 of this APR.

B. Mine Rescue - The Mine Rescue Program has been upgraded with the purchase of five new Drager self-contained breathing apparatus, reaching a full complement of fifteen units. An RZ-25 testing unit and a Haskell oxygen pump have been installed to keep the units in a state of constant readiness. The Haskell oxygen pump is also used to fill medical oxygen cylinders for the RBOSC ambulances. A backup compressor for the Haskell oxygen pump was also purchased and installed. The Mine Rescue Training Room and the first aid stations have been completed. Figure 2-4-10 shows the Mine Rescue Training Room. A total of 40 men were trained and qualified for mine rescue at the end of the year.

Mine self-rescue units are physically checked and weighed monthly to assure the units are in good working order. Results of the inspection are logged and filed in the Safety Department. Damaged units are used for self-rescuer training.

C. Mine Emergency - A positive identification system for persons working underground has been implemented. The miner's name and social security number are engraved on a tag that is riveted to the miner's belt. This is used in conjunction with the mine "log in" and "log out" board on the surface.

Fire extinguishers and first aid kits have been placed in strategic locations on each level underground. Laminated mine maps showing the direction of ventilation and the route to the surface have also been placed on each level. A routine monthly check program is in existence and fire extinguishers are recharged on tract by trained personnel.



FIGURE 2-4-10
MINE RESCUE TRAINING ROOM

SECTION III

PROCESSING

Construction of the Process Facility was completed in March 1980.

In addition to substantial rework and repair from routine shakedown and startup, there were several items of major importance that required redesign and rework. Briefly these are summarized as follows:

- The three 36" fabric expansion joints in the toxic off-gas service were unacceptable as designed and required replacement with stainless steel joints prior to ignition.
- The 10-foot diameter fabric joints between the incinerator and scrubber and between the scrubber and stack also developed leaks that required considerable redesign work.
- Failure to grout the foundation anchor bolt sleeves of the C-101 and C-102 compressors resulted in cracked foundations. These foundations were replaced.
- Numerous design revisions were made to the flare, water seal, and off-gas piping and instrumentation to allow the retort to operate safely under negative pressure at the bottom of the retort.
- A crossover water line between the firewater line and process water line was installed to insure that the process plant will always have an adequate supply of water for cooling.

1.1 SUPPORT FACILITIES

Following are some of the specific areas of design and construction carried out in 1980 which were outside the final scope of the construction contract.

A. 1000 KW Generator and Auxiliar Suction Blowers - In May, 1980, a contract was awarded to provide an emergency power package consisting of a 1000 KW diesel drive generator and automatic transfer station and two auxiliary powered 200 hp. suction blowers installed in parallel with the existing C-102 suction compressor. The 1000 KW generator, the "B" and "C" auxiliary blowers are shown in Figures 3-1-1 and 3-1-2. The emergency package would assure



FIGURE 3-1-1
1000 KW DIESEL GENERATOR

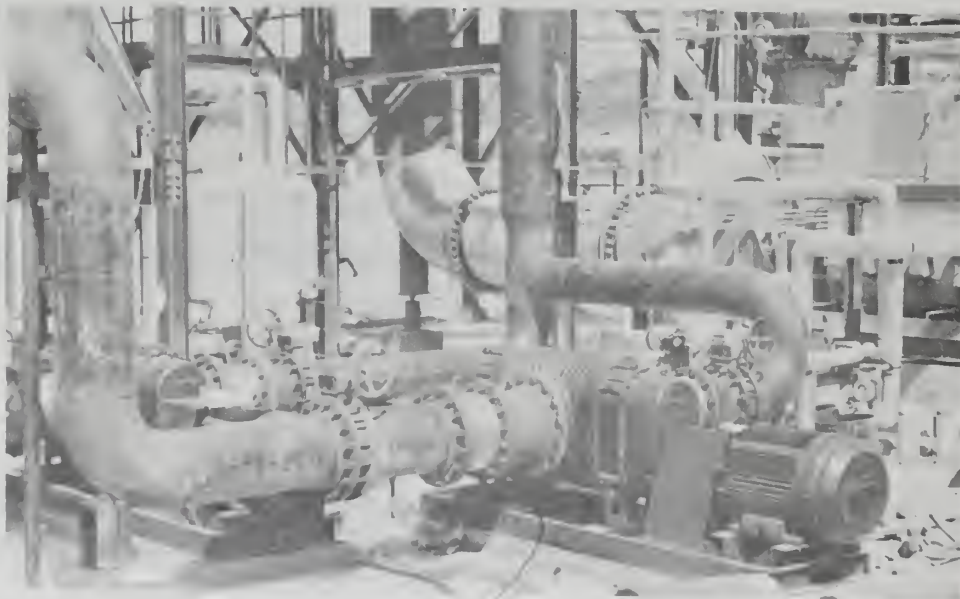


FIGURE 3-1-2
AUXILIARY BLOWERS

that the retort could be safely operated under slight negative pressure even in case of a power outage. In addition to supplying power to the the "B" and "C" auxiliary blowers, the 1000 KW generator would also supply backup power to the auxiliary mine ventilation fan, the package boiler, the auxiliary instrument air compressor, and the emergency escape hoist. All the basic engineering and installation work were performed in the field.

B. Evaporation Ponds - In June, 1980, installation of the pond liners on the Phase I pond construction was completed. The south pond had to be patched twice before it was accepted as leak free. These ponds were described in the 1979 Annual Progress Report.

A separate contract was awarded for construction of a Phase II pond system. This system consisted of three lined evaporation ponds similar in construction to the Phase I ponds and totaling 965,000 ft.³ capacity. All three ponds were lined with 36 mil Hypalon, a high grade polymer coated fabric liner (see Figure 3-1-3). These ponds were designed to provide sufficient capacity for evaporation of sour water and scrubber blowdown for both Retort Zero and Retort One. The location of these ponds are shown on Figure 1-2-5 and 1-2-7.

C. Downhole Ignition Burner - A contract was awarded to design the downhole burner, skid mounted burner control package and remote control panel. RBOSC field personnel provided the process engineering and design specifications.



FIGURE 3-1-3
PHASE II EVAPORATION POND SYSTEM

D. Retort Zero Piping and Instrumentation - In June and July 1980, the RBOSC field personnel designed and installed the surface piping to Retort Zero. This included fuel gas and combustion air for the ignition burner plus steam and air lines for retorting (see Figure 3-1-4).



FIGURE 3-1-4
RETORT ZERO PIPING

Colorado Well Service was contracted to pack off the burner sleeve and to lower the downhole burner. These activities were completed in August and September 1980, respectively. Additionally, six of the blastholes were equipped with tracer lines and observation thermocouples.

E. Process Computer - A Hewlett Packard Spec 200 computer was purchased and delivered in June 1980 and installed in July of 1980 prior to Retort Zero ignition. Pertinent process data was wired into the computer for data acquisition. Amoco Research in Naperville, Illinois specified the computer system, developed the software package, and assisted the RBSOC field personnel in installation and computer services during operations. Set Point, Inc. of Houston Texas was also contracted by Amoco Research to develop the software design, assist in programming and service/maintenance of the computer during operation.

F. Analyzers - Process analyzers and an analyzer building were purchased and installed in September 1980. This system did not perform satisfactorily during Retort Zero largely because of higher quantities of C_6+ than design and increased ranges on other components from variations in process operations. This system will be modified before the Retort One burn. Also, a separate backup system is being designed to provide continuous data of major components while the primary system is being serviced.

G. Underground Process Equipment - Process equipment and the underground quench system were installed in the underground pump room in August and September 1980. Serious nozzle plugging problems occurred which hampered the retort operation toward the end of the burn. This system is being redesigned for Retort One.

H. Screen And Scale Unit - A screening plant and scale unit were set up in the ROM area during the last quarter of 1980 to screen oil shale for testing purposes. Primary use of this unit was determination of the particle size distribution of retort rubble.

I. Miscellaneous - In November 1980 asphalt was laid around incinerator stack to prevent runoff water from collecting and saturating the ground around this stack. In June 1980 a new collar was installed in the instrument shaft and an electrical duct bank was installed between manhole-3 and the escape shaft hoist building.

2.1 SUMMARY OF PRESSURE AND TRACER TEST

Prior to ignition a series of Retort Zero flow and tracer tests were completed, resulting in important information on the nature of the retort. From this information the staff finalized procedures, operation, expected performance and the effectiveness of the RBOSC method of retort preparation. The tests are herein briefly summarized:

A. Cold Flow Pressure Drop - Pressure drops over the Retort Zero were measured at various air flow rates. Measured pressure drops inferred that the rubble contained a high proportion of fine material. While the high pressure drop would eventually limit the retort burn rate, Retort Zero was processed at a rate significantly higher than rates reported by others.

B. Pressure Rise Test - The retort was sealed at its outlet by surface valves and at the G-level of the mine by four bulkheads which isolate the underground product collection system from the mine workings. The system was then pressured with air and the rate of pressure rise was monitored at the rubble top and bottom. These tests indicated that most of the leakage was in the underground collection system (around the bulkheads) rather than in the retort itself. The pressure rise data was used to calculate the rubble void volume.

C. Tracer Flow Test - Five separately identifiable freon gases were injected into different sections of the top of the rubble bed. The injections were simultaneous and arrival times were measured at the retort bottom. Data were collected at two air flow rates. The tests indicated excellent uniformity of flow of gases through the retort, and significant advances over other MIS technology for retort preparation.

D. Mine Leak Testing - The mine was tested to identify and quantify leak locations and leak rates to the mine workings. Sulfur hexafluoride gas (SF_6)

was mixed with circulating air while the underground product collection system was held at a vacuum. Then the product collection system was quickly brought to +12" H₂O pressure. SF₆ was monitored at 16 locations on each of Sub-E and G-Levels. Sub-E is the dewatering level, located close to the top of Retort Zero. No drifts connect the retort with Sub-E-Level. G-Level is the production collection level and the location of the product pump room and of mining activities for preparing Retort One. G-Level is separated from retort off gases by bulkheads at four locations. Figure 3-2-1 shows the G-Level sampling locations and the product collection system bulkheads. No SF₆ was found on Sub-E-Level, but SF₆ was detected within minutes after pressurization on G-Level. Results indicated about 200 SCFM leakage, almost entirely around bulkheads. Projected H₂S levels under these conditions indicated that unsafe levels of H₂S would be reached if the product collection system was inadvertently pressurized during operations. A second test was run after additional shotcreting of critical areas on G-Level. Results essentially duplicated those of the first test, indicating the difficulty of stopping small leaks through fractured rock.

A "doomsday" test was conducted by completely shutting off mine power, hence ventilation, simultaneously pressuring to 10" H₂O and sampling for SF₆ in the product pump room and in the Retort One mining area. Within the ten minute test period SF₆ was detected in the vicinity of the Retort One bulkhead, but not at the other three locations. Lacking ventilation to carry leakage away from the bulkheads, SF₆ did not mix rapidly with mine air. Given warning of impending positive pressure in the product collection area, there should be ample time to vacate the mine.

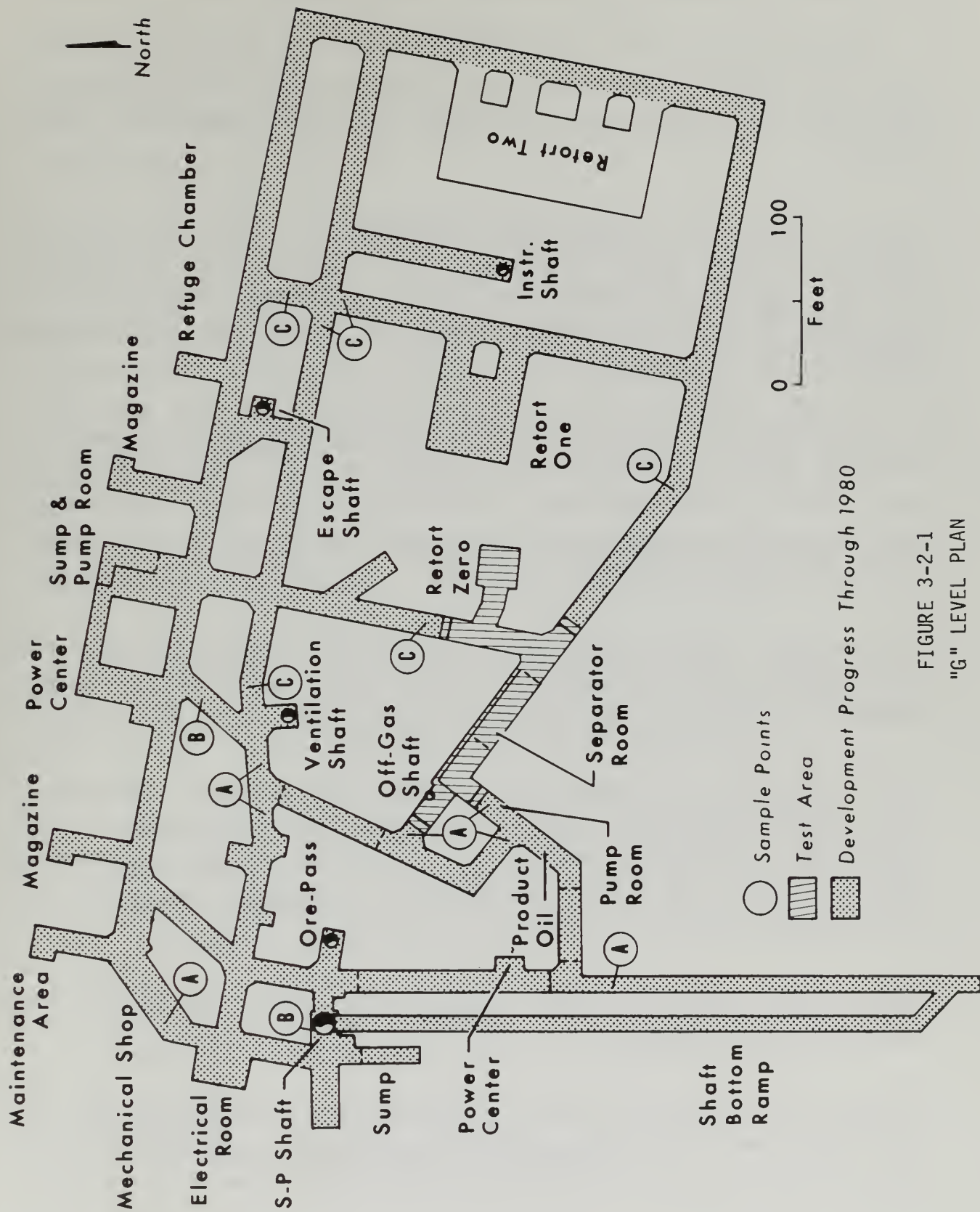


FIGURE 3-2-1
"G" LEVEL PLAN

2.2 OPERATION SUMMARY

A. Ignition Phase - Surface tests of the specially designed downhole burner system confirmed that the burner would operate reliably as designed over a broad operating range while using excess air as the temperature quench medium.

Ignition of Retort Zero was started at 1:30 a.m., October 13, 1980. The ignition proceeded smoothly as planned. The downhole burner performed as expected. Ignition was complete by 4:30 p.m., October 14 (39 hours). At that time, retorting was established over the entire rubble bed and the downhole burner was turned off.

B. Operation Phase - Phase I operation from October 14, through November 8, proceeded smoothly and pretty much according to plan. Initial retorting conditions were established using a mixture of air and steam. However there were test periods where retorting was performed with 100% air to test commercial implications of straight air retorting.

The one major incident during this period occurred on October 22, when the air compressor motor burned out. However normal retorting was quickly resumed using air supplied by the mine air compressors.

Since there was no instrumentation in Retort Zero, retorting rates during this period were predicted by the Lawrence Livermore Laboratory retort model and empirical correlation developed from past pilot retorting experiments. These rates were fairly well substantiated by independent correlations of off-gas composition with grade, and mineralogical data.

Pressure drop across the retort behaved pretty much as projected by the pre-ignition cold flow test.

Air was first cut out of the retort on November 20, in anticipation that the retorting process was nearing completion and would be completed with 100% steam. After 4.5 days of straight steam retorting, air was re-introduced to

the retort after it became evident that the expected temperature breakthrough was not going to occur (rapid increase up to 300°F or above).

Retorting continued with a steam/air mixture until air injection was terminated for the second time on December 10 in anticipation of a temperature breakthrough.

The expected high exit temperature breakthrough still did not occur even though the offgas temperature did increase above the dew point. Thus air was re-introduced to the retort for the third and final time on December 17. By this time the quench water system for controlling off-gas temperatures was experiencing severe plugging problems and left the operators with no way to deal with high exit temperatures. It was then decided to terminate air injection on December 20 and residual heat in the retort was used to complete Retort Zero processing.

The retort was successfully cooled down with steam and recycling of sour water through the spent shale.

C. Post Burn Studies - Final analysis of Retort Zero data is still in progress, and will be for months to come. However, the missions of Retort Zero were fulfilled and the following observations are in order:

- Final oil accumulation was approximately 1040 barrels of oil recovered in the tanks with another 710 barrels of potentially recoverable oil in the off-gas for a total of 1750 barrels. About 90% of the accessible oil (as limited by thermodynamics) in the retort was recovered.
- The rubbing technique produced a rubble with even distribution of void space as evidenced by tracer test prior to the burn.
- The rubble was somewhat finer in size than expected. Consequently, the pressure drop was greater than design.

- All surface equipment was run successfully and debugged.
- Severe corrosion problems were encountered in the scrubber area, particularly the incinerator stack. This is a carbon steel stack lined with mastic. Severe corrosion occurred in several places where the mastic either cracked around the weld area and/or where pin hole leaks occurred in the mastic. Also a number of the small diameter lines in the scrubber area had to be replaced with stainless steel.

No significant corrosion was found upstream of the incinerator/scrubber because there was sufficient ammonia in the retort off-gas to maintain the condensate Ph in the 8 to 9 range.

- There were no major safety incidents in the mine or on the surface. At no time during the burn was any mine personnel subjected to toxic levels of retort off-gas even though there were several positive pressure excursions in the underground separator room, due to switching of suction blowers on the surface. Mine evacuation procedures worked smoothly with all personnel being able to exit the mine within 10 minutes after sounding the alarm.
- A significant achievement of Retort Zero was the successful continuation of underground mining operations and rubblization of Retort One in the proximity of and concurrent with the burning of Retort Zero.

D. Unanswered Questions - Because of lack of instrumentation in Retort Zero, an unanswered question remains as to how near to the bottom of the retort was the combustion front. Although RBOSC calculations based upon air consumption and oil burning losses would indicate that the retort and combustion fronts were indeed very close to the exit, this assumption cannot be proved until some future time where samples can be recovered from the bottom of the retort.

It is also speculated that a certain amount of the oil may still be held up in the rubble at the bottom of the retort. Samples will also answer this question.

3.1 OUTLOOK

Retort One is currently scheduled to be ignited in May, 1981. The following design changes are being incorporated into Retort One design:

- A total of 20 additional thermocouples will be embedded in the retort exit rubble to monitor temperatures at the bottom of the retort. Thus with the existing thermocouple and pressure profile design, there should be sufficient instrumentation to pinpoint the combustion front throughout the retort.
- Since RBOSC does not now plan to enter the instrument shaft after ignition, the pressure transmitters for the retort pressure profile are being located on the surface, rather than underground thus allowing for maintenance and range changes as necessary during the burn.
- The quench system has been totally redesigned to include a primary retractable probe quench system, plus an alternate backup quench system. In addition zeolite softened water will be used to minimize plugging problems.
- A new oil sample system will be designed to permit spot retort oil sampling from the bottom of the retort, avoiding the long hold up time in the underground separator room.

3.2 MAJOR DESIGN CHANGES:

In the surface plant, major design changes will include:

- Revamping of the off-gas sampling and conditioning system and backup gas chromatograph.

- Revamping the "B" and "C" blower suction and discharge piping.
- Installation of an alternate off-gas meter run to permit better measurement of the retort off-gas and install main line check valve to incinerator/flare to prevent air feedback on C-102 failure.
- A redesigned Water Management program. In general, excessive amounts of sour water, scrubber flowdown water and general process blowdown (East Pond water) were generated during Retort Zero.
- Upgrade the computer terminal and graphics capabilities.
- Correct certain instrumentation deficiencies.
- Installation of a flue gas blower upstream to provide a source of inert gas for retort purge.

CHAPTER 4
SURFACE RETORTING
LURGI DEMONSTRATION PROJECT

In March an agreement was entered into with Lurgi Kohle Und Mineralöltechnik GmbH for the design of a nominal 4,400 ton per stream day (TPSD) Lurgi-Ruhrgas surface retort. In July an agreement was entered into with The Lummus Company for erection of the Lurgi-Ruhrgas retort and design and construction of the support facilities. The proposed development plan consists of a two-year construction period and up to three years of operation of the surface retort. The plant, support facilities and overburden and processed shale disposal sites will be located on RBOSC off-tract property north of and adjacent to Tract C-a (Figure 3-4-1). The surface rights to this 457-acre site was obtained by an agreement with the Colorado Division of Wildlife.

The plan also includes a small open pit mine to provide feed shale to the surface retort. MIS development may not prove to be the best approach for the commercial development of Tract C-a. Legislation to give the Secretary of the Interior the authority to make off-tract land available failed to pass in Congress in 1980 but is expected to be reintroduced during the 1981 session of Congress. Thus, an open pit mine with a surface retort demonstration unit would be valuable to evaluate. Whether RBOSC proceeds with an MIS or open pit commercial plan, surface retorting of oil shale is required for maximum conservation of the resources. The construction and operations schedule is shown on Figure 3-4-2.

By year end, Lummus and Lurgi were progressing with their planning and design efforts. In order to gain a more convenient entry to the RBOSC off-tract property, RBOSC requested and received approval from the OSO in the fall of 1980 to construct a service access road from the tract entrance to the Lurgi processing and support facilities area. Location of this road, shown on Figure 1-2-6 as the "Lurgi Access Road" was constructed in the late fall of 1980 to the Tract C-a boundary and completed in January 1981. The road allows

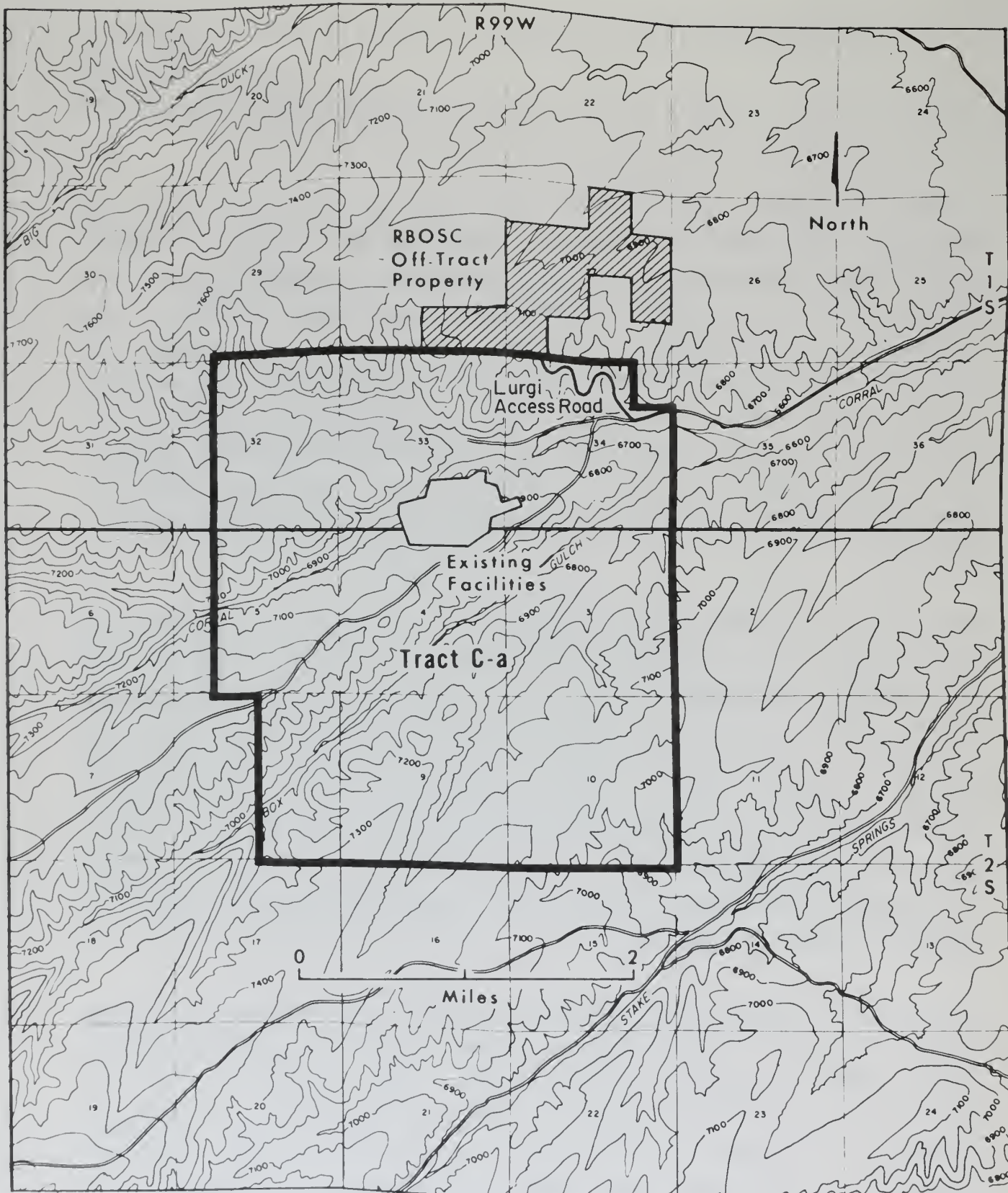


FIGURE 3-4-1
LURGI DEMONSTRATION PROJECT OFF-TRACT SITE LOCATION

RBOSC MDP Schedule of Lurgi Demonstration Project

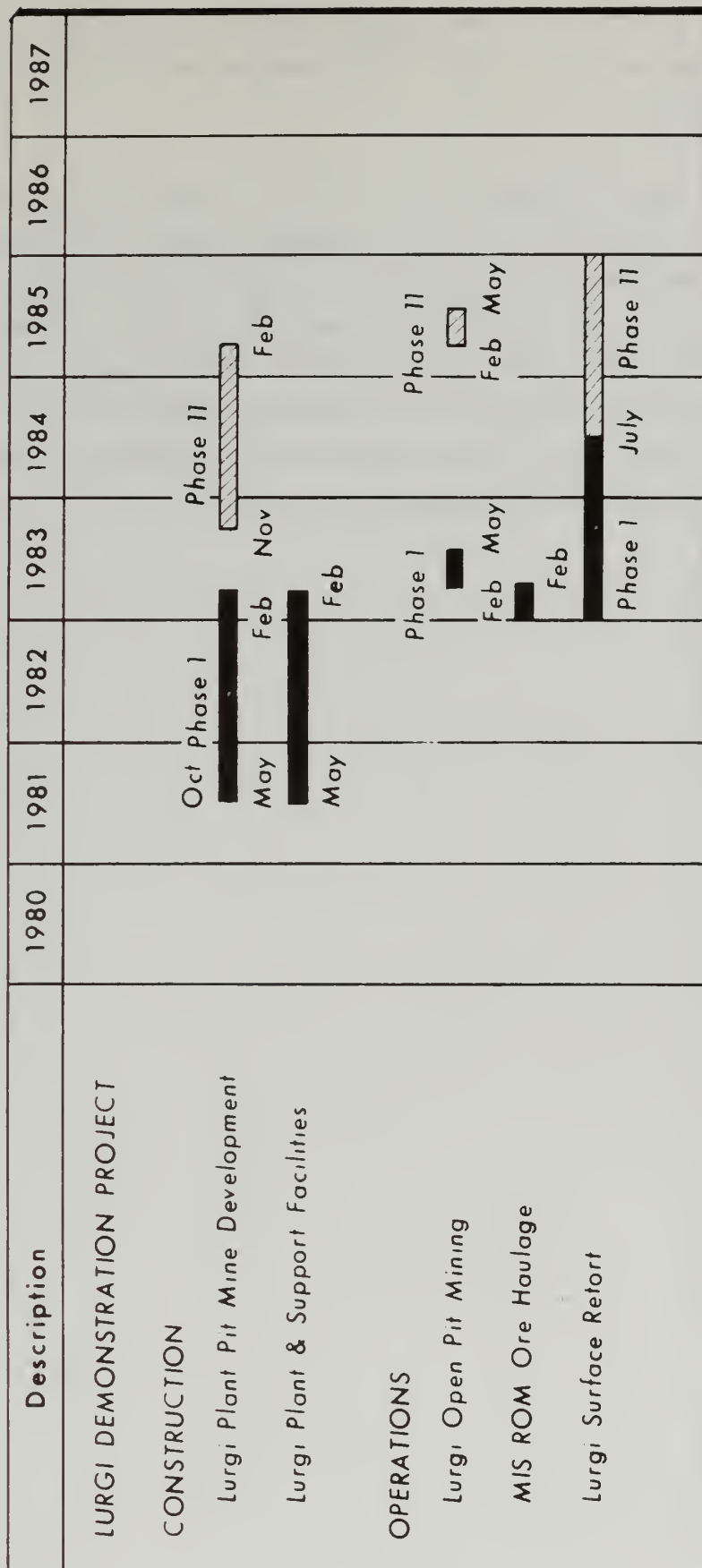


FIGURE 3-4-2
RBOSC CONSTRUCTION AND OPERATION SCHEDULE

quicker and safer entrance to the project area for plant and disposal site surveying work, geotechnical work, environmental monitoring, and general project planning work.

Geotechnical work was performed in the fall of 1980 in four areas: soils investigations in the plant site area (Woodward-Clyde Consultants); soils investigation in the open pit area (Morrison-Knudsen); hydrologic investigation in the pit area (Law Engineers and Testing); and soils investigation in the processed shale and disposal area (Golder Associates). All necessary approvals for this Lurgi related work was obtained from the OSO, Colorado Air Pollution Control Division, Colorado Mined Land Reclamation Board and the Colorado Historical Society (archeological clearance).

SECTION IV

ORE STORAGE

The ROM ore storage pile was extended to the north and to the east, cutting off the old Hunting Camp access road. All of the muck from shaft sinking, drifting, raise boring and retort rubble draw has been placed on the stockpile. This amounts to 121,100 tons with a volume of 133,220 loose cubic yards.

A lysimeter for leachate study has been installed along the southeast side of the stockpile.

Localized heating has occurred in the pile. A study is planned to determine the cause, extent and effects of the heating.

SECTION V

SUPPORT FACILITIES

During early 1980, buses were introduced as the primary mode of transportation to the site from Rifle and Meeker. Three buses during weekdays and one bus during the off-shifts and the weekend shifts are provided from Rifle with three vans utilized for overflow. Meeker has one bus for dayshift during the week with two vans taking care of all off-shifts and weekends. Rangely's transportation is supplied by two vans covering all shifts. A motorpool system has been set up to provide for various transportation needs on and off site.

1.1 AIRSTRIP UPGRADING AND PAVING

During 1979 a 5,000 foot, 50 foot wide unpaved airstrip was constructed. Because of increased activity in the area by RBOSC on Tract C-a and various other energy developments a decision was made to upgrade the airstrip in 1980. This decision was encouraged by the BLM and OSO. The airstrip was extended to a total length of 5,600 feet. The subgrade was reshaped and compacted. Four inches of road base gravel were placed and compacted. One and one-half inches of Bituminous Surface Course was placed to make the upgraded airstrip an all-weather facility. The width of the paved runway is 48 feet. The airstrip is not open to public use, but is available to federal, state and local governmental officials for use in the course of their official duties, or by prior written agreement with RBOSC. The word RESTRICTED is painted on both ends of the runway indicating the airstrip is not open to public use. Figure 5-1-1 shows the location of the airstrip relative to Tract C-a. The paved runway is shown on Figure 5-1-2.

1.2 LURGI ACCESS ROAD

The proposed surface retort is to be constructed on land bordering the north of Tract C-a. Other reasons given on pages 3-4-1 and 3-4-4 in order to have access to the plant site when permits are received in 1981 the decision was

made to construct an access road as early as possible. The access road is 5600 feet long with two 18 foot wide lanes. The road has an 8 percent grade its entire length. Final surfacing will likely include gravel base course and asphalt surfacing. By the end of 1980 the road was nearly complete to subgrade. See Figure 1-2-6 (Plot Plan) for road location.

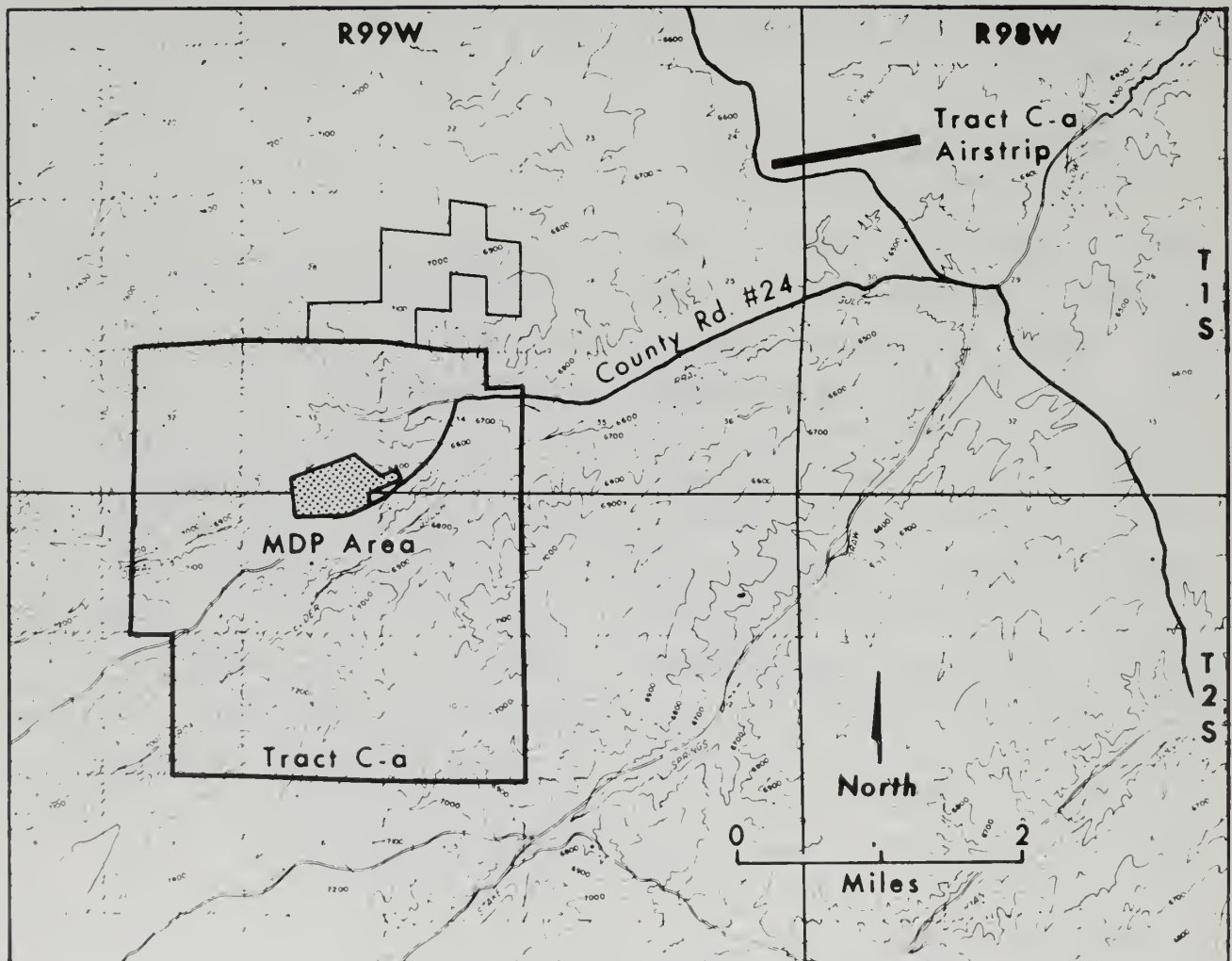


FIGURE 5-1-1
LOCATION OF TRACT C-a AIRSTRIP



FIGURE 5-1-2
PAVED AIR STRIP

2.1 ELECTRICAL

RBOSC designed and installed several major power systems during the year 1980. Both the replacement of the damaged duct bank between Manhole-2 and Manhole-3 and the design and installation of the automatic startup system on the 2500 KW O'Brien standby generator were completed in March, 1980.

RBOSC installed the pole lines and the pumps for Dewatering Wells No.'s 6 and 8, and for the Booster Pump in Box Elder Gulch in April of 1980. The installation of 4.16 KV disconnect switches for each site building were also completed during the month of April. In May, 1980, RBOSC installed a duct bank and 4.16 KV power to the new Service Escape Shaft Hoist House. A dedicated 1000 KW emergency power generating system was designed and installed for the Process Area during August, 1980. Electrical power to the Bachelor Emergency Quarters and the Process Water Pump system were installed in October, 1980. Installation was completed and electrical power was energized to Retort One's Multiplexer building and the Instrument Hoist House during November, 1980.

2.2 NATURAL GAS

During 1980 several extensions were added to the natural gas pipeline routing on Tract C-a as follows:

- In June a one-inch gas main was extended to the Mine Fabrication Shop.
- In October a three-inch gas main was extended to the shaft air tempering unit from the Production Shaft.
- During December a two-inch gas main was extended to serve the Lurgi trailer complex.

The natural gas pipeline routing is shown on Figure 5-2-1.

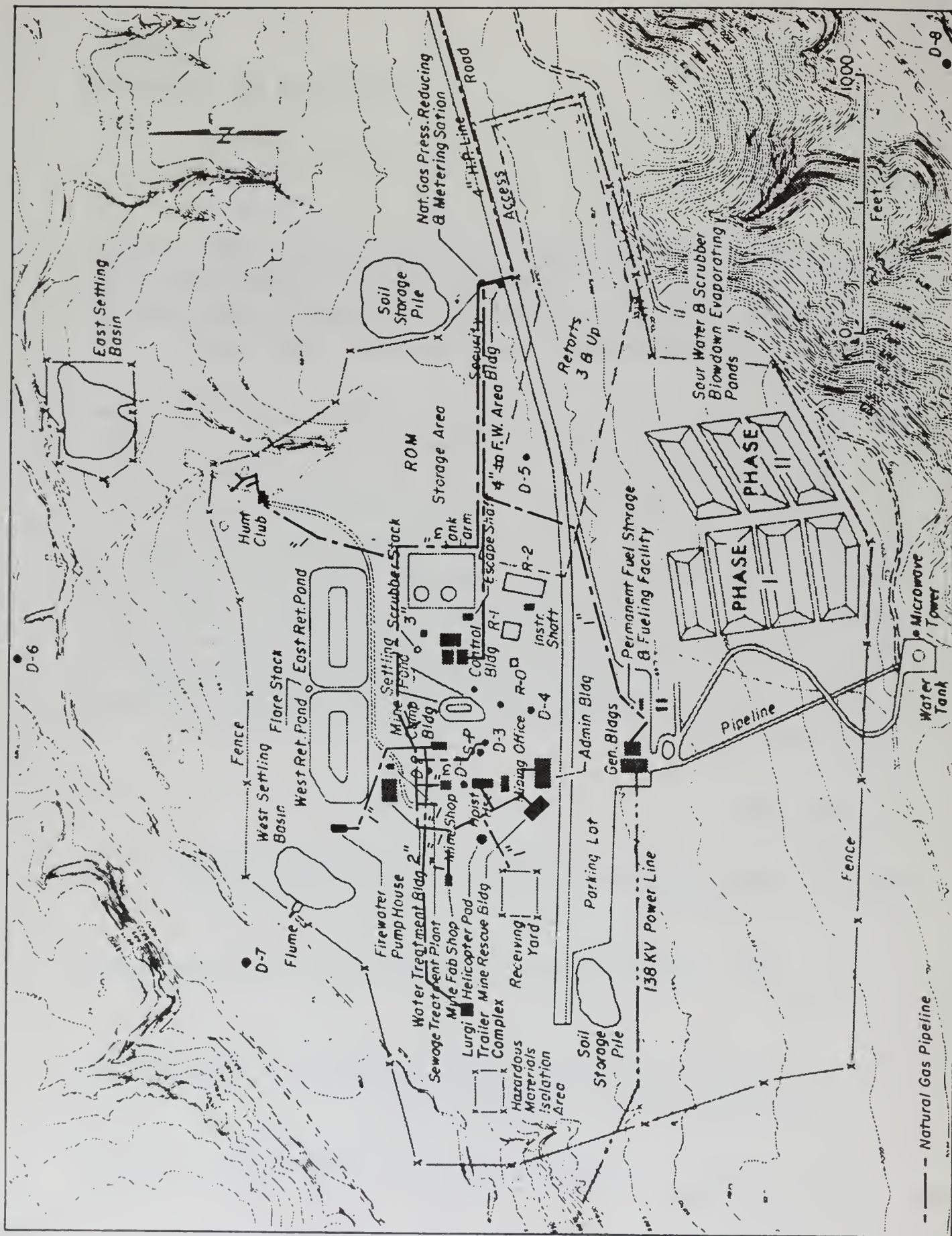


FIGURE 5-2-1
NATURAL GAS PIPELINE ROUTING

3.1 GENERAL CONCEPT

The water management program for MIS, as shown in Figure 5-3-1, is being reevaluated since Retort Zero was burned in late 1980. The volumes and qualities of process water were much greater than anticipated and the volume of mine drainage from Sub-E-Level was much less than anticipated. The NPDES permit is being amended to provide more operating flexibility in the MIS operation. The augmentation plan still requires the reinjection of all excess mine effluent except for maintenance discharges to contain the cone of depression.

3.2 STATUS

A. Potable Water Plant

In April, 1980, RBOSC began producing its own potable water. This water originates as mine seepage water. It is settled, chemically treated, filtered and softened and chlorinated before being pumped into the potable water system. This plant is monitored on a daily basis according to Colorado State primary drinking water standards. Bottled drinking water is also available at various points on the site.

Thus far the plant has produced more than 2 million gallons, or an average of 8,500 gallons per day, of potable water.

B. Sewage Treatment Plant

The plant is presently operating at about 8,000 gpd which is 60% of its capacity. As of December, 1980, the plant was producing effluent well within the Colorado State limitations. There have been no plant upsets or difficulties during its operation. Valley Disposal of Meeker disposed of approximately 6,000 gallons of aerated, digested sludge during 1980.

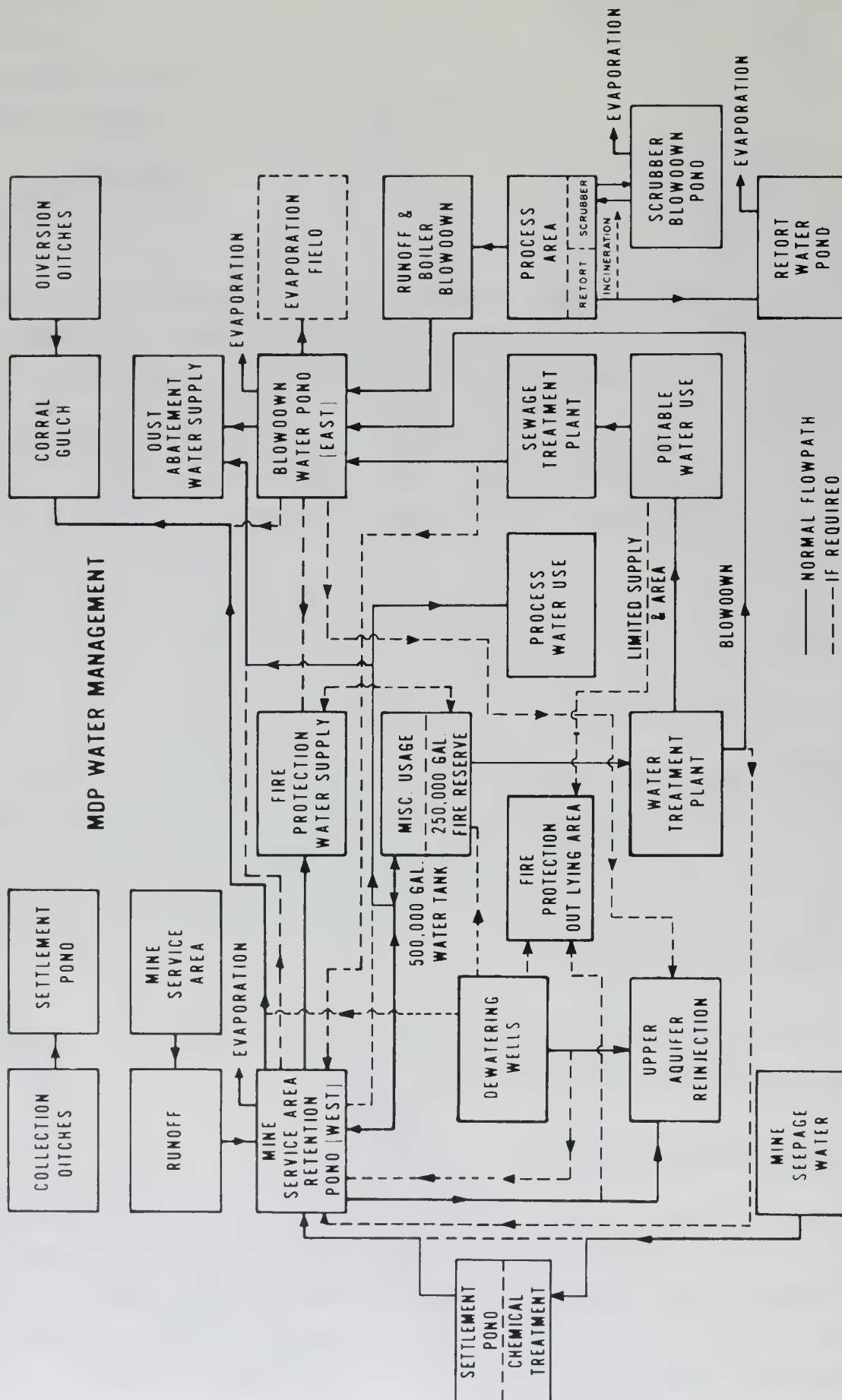


FIGURE 5-3-1
MDP MANAGEMENT SYSTEM

C. Dewatering and ReInjection

Two additional reinjection wells (GS-20 and GS-21) were installed in the southeast corner of the tract during 1980 and the last two of four additional dewatering wells (D-6 and D-7) were drilled in Corral Gulch. The Sub-E-Level drainage gallery was effective in reducing water levels near the retorts without producing large volumes of water, so development of the unproductive wells was not necessary. Dewatering well D-5 was abandoned in October because of substantial reduction in flow rate of water after the development of Sub-E-Level. Ten inch pipelines were installed to connect the new dewatering and reinjection wells to the reinjection system pipeline. A 300 hp booster pump station was installed in Box Elder Gulch. Only two of the dewatering wells (D-6 and D-8) and one reinjection well (GS-21) had sufficient capacities to be brought into production without extensive well development. The locations of these wells are shown on Figure 5-3-2.

About 80% of the water produced during 1980 was reinjected, about 15% was consumed and about 5% was discharged. Table 5-3-1 is a monthly summary of water production and disposition. Figure 5-3-3 shows cumulative volume of water pumped and reinjected 1978-1980.

RBOSC also constructed a process water pump (floating) station during August-September of 1980. This system was constructed to supply water with fewer solids and in greater quantities than was possible with the original process pumps at Fire Water Pump House. The Floating Process Water Pump Station is shown on Figure 5-3-4.

During July of 1980, leakage tests were conducted on the Phase I Sour Water Evaporation Ponds 1-4. Leakage tests for Phase II Ponds 5-7 were completed in November.

In order to eliminate mine water with a "heavy suspended solids" concentration from entering the West Retention Pond directly, the settling pond (Jeffrey Pond) near the S-P shaft shown on Figure 1-2-5, was incorporated into the Mine drainage system.

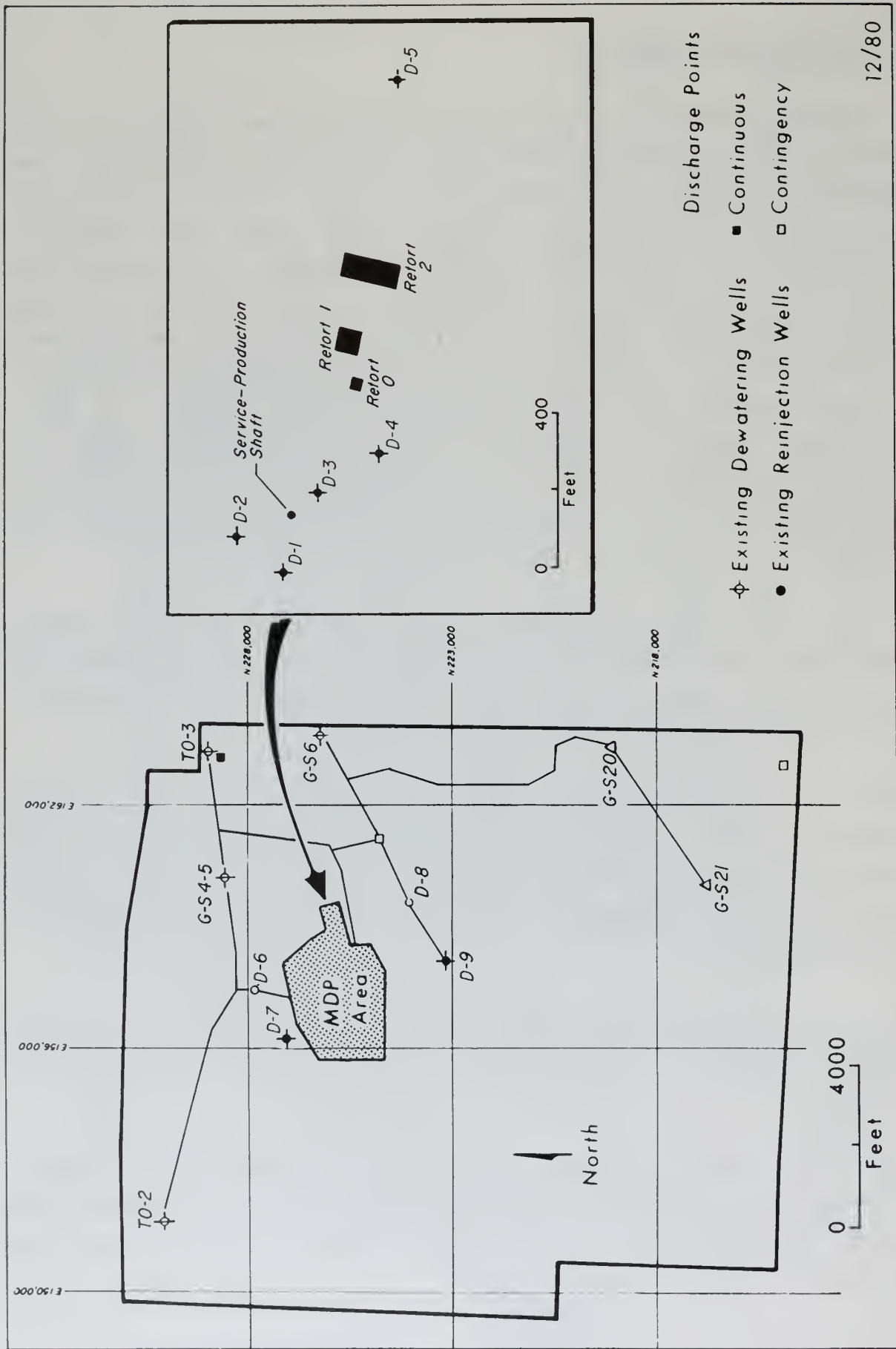


FIGURE 5-3-2
TRACT C-a DEWATERING - REINJECTION PROGRAM

12/80

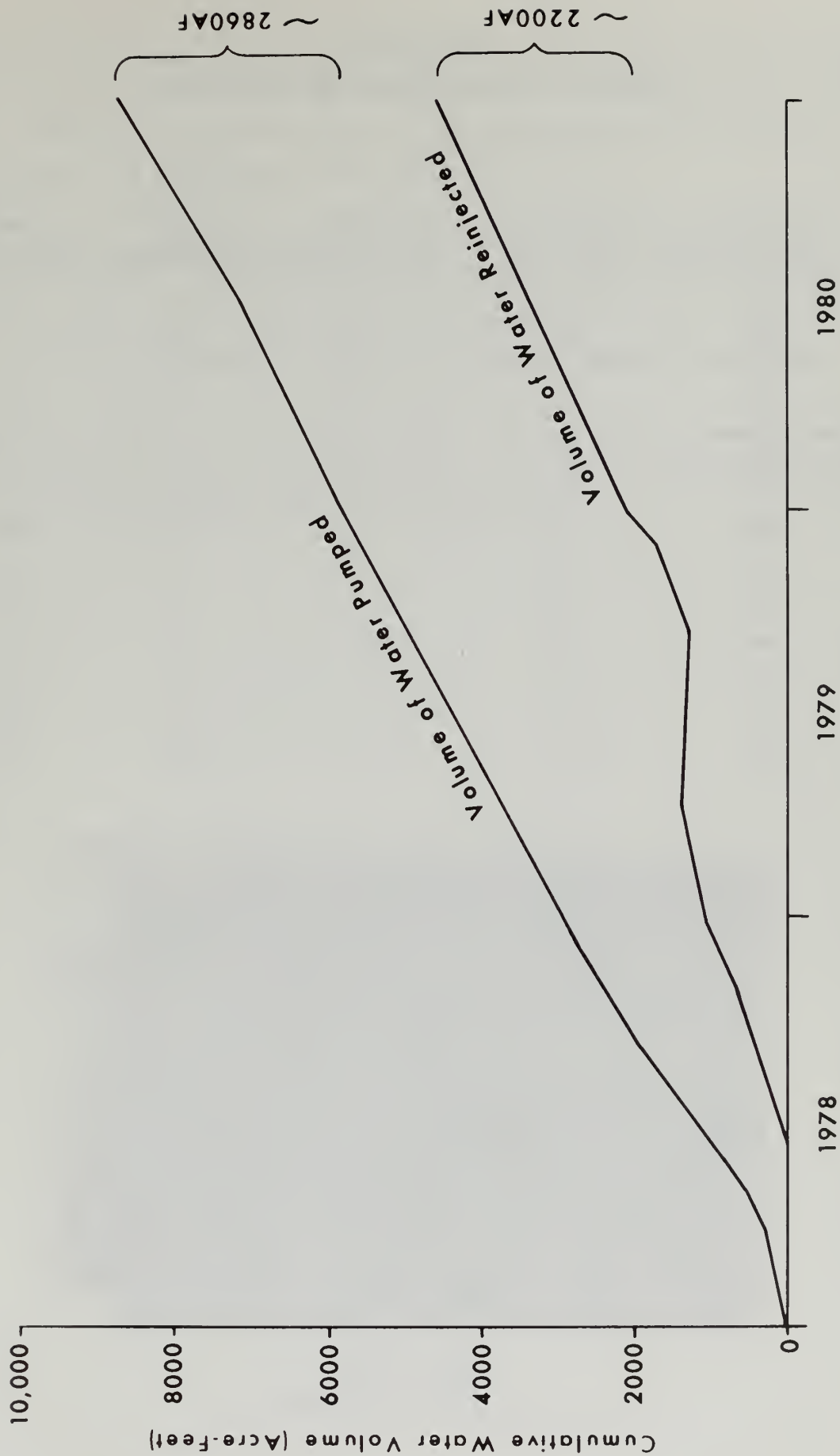


FIGURE 5-3-2
CUMULATIVE VOLUME OF WATER PUMPED AND REINJECTED 1978-1980

TABLE 5-3-1
SUMMARY OF WATER PRODUCTION AND DISPOSITION

<u>Month</u>	<u>Production 10⁶ Gallons</u>	<u>Reinjection 10⁶ Gallons</u>	<u>Discharge 10⁶ Gallons</u>	<u>Consumptive Use 10⁶ Gallons</u>	<u>Losses/ Accumulation 10⁶ Gallons</u>
Jan.	67	51	3	7	+ 6
Feb.	67	58	3	10	- 4
Mar.	69	67	0	7	- 5
April	63	63	1	9	-10
May	89	54	27	11	- 3
June	80	54	9	13	+ 4
July	85	60	0	13	+12
Aug.	87	60	6	13	+ 8
Sept.	88	65	0	19	+ 4
Oct.	89	74	0	22	- 7
Nov.	76	52	0	41	-17
Dec.	<u>71</u>	<u>56</u>	<u>3</u>	<u>27</u>	<u>-15</u>
TOTAL	931	714	52	192	-27



FIGURE 5-3-4
FLOATING PROCESS WATER PUMP STATION

The mine water now enters the Jeffrey Pond where FLOCCULATING chemicals are added to assist in the settling out process of the suspended solids. This change has reduced the suspended solids in the pond overflow and effluents -- to process water or to reinjection to the aquifer.

D. Erosion Control (Runoff Water) - A new 48-inch tar coated corrugated metal culvert pipe was installed in Corral Gulch Road below Visitors Center. A 36-inch corrugated metal culvert pipe was replaced with a tar coated pipe in Corral Gulch to mitigate the erosion problem south of Bachelor's Quarters.

E. Skimming Equipment - In December 1980, low capacity skimmers were installed in the west and east retention ponds, to clean oil film which might appear on the surface of either pond. See Figure 5-3-5.



FIGURE 5-3-5
SKIMMING EQUIPMENT

Three major improvements to communications systems were completed during 1980.

- In early 1980, a UNICOM VHF communication system was installed whereby a pilot can contact the tract to obtain airstrip conditions prior to landing.
- In early 1980, Mountain Bell completed de-bugging processes to allow full utilization of all 18 telephone lines to the tract.
- In November, 1980, Mountain Bell installed equipment for Standard Oil telecommunications network tie lines and WATS lines which are projected for "turn-up" in early 1981. The Administration Building telephone room was expanded to house this new equipment.

CHAPTER 5
STORAGE AND DISTRIBUTION
OF FUEL AND OTHER
SERVICE PRODUCTS

Figure 5-5-1 is a location drawing for the five permanent and five other fuel tanks located in the MDP construction and operations area. All permanent tanks are located underground and were installed prior to 1980 except the 300 gallon Mine Diesel Tank which was installed in 1980. The table below identified the tanks and gives their usage and capacities.

	<u>Location</u>	<u>Capacity (Gallons)</u>
1.	Generator Substation-Unleaded Gasoline (Underground)	10,000
2.	Generator Substation-Regular Gasoline (Underground)	10,000
3.	Generator Substation-Diesel (Underground)	20,000
4.	Parking Bench-Unleaded Gasoline	5,000
5.	Parking Bench-#1 Diesel	10,000
6.	Parking Bench-#2 Diesel	5,000
7.	Administration-Diesel (Underground)	10,000
8.	Process Tank Farm-Diesel	10,000
9.	Parking Bench-#1 and #2 Diesel Mix	10,000
10.	Mine Diesel-Diesel (Underground)	300

An estimate of the gasoline and diesel usage by quarter at Tract C-a for 1980 is given as follows:

<u>Quarter-1980</u>	<u>Gasoline (Gallons)</u>	<u>Diesel (Gallons)</u>
1st	42,970	35,000
2nd	40,766	68,980
3rd	51,017	50,810
4th	43,206	48,031

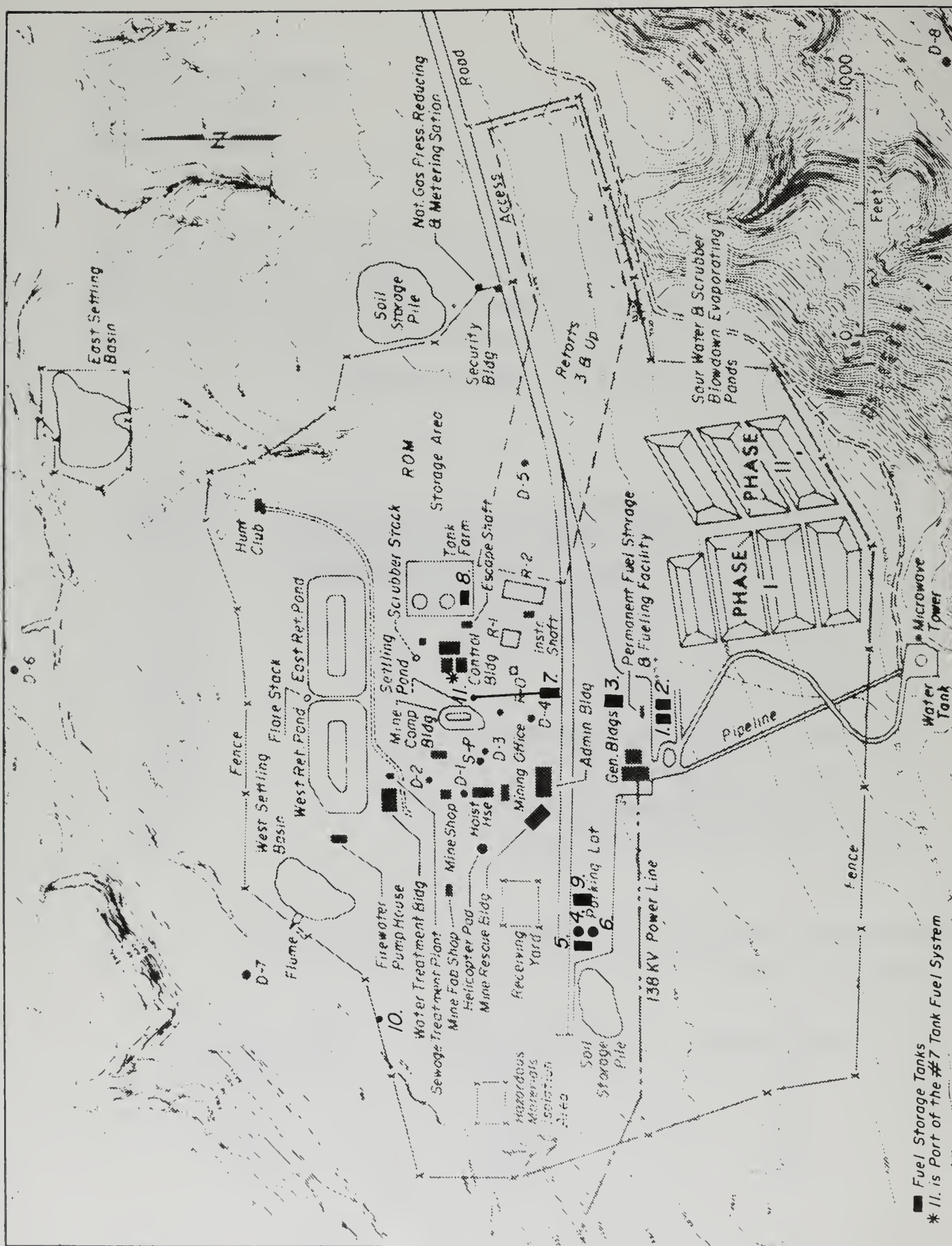


FIGURE 5-5-1
LOCATION OF FUEL STORAGE TANKS

RBOSC completed construction of three major buildings and one building addition in 1980. The Service Escape Hoist building was completed and put in use in February, 1980. The Instrument Hoist and Multiplexer buildings and a Mine Office building were completed in September, 1980. These buildings are shown in Figures 5-6-1 through 5-6-3, respectively. The addition the Maintenance Fabrication Shop was completed and in use by November, 1980.

RBOSC also set up various trailer complexes and individual housing units and other buildings in 1980 (and late 1979). These included construction of a 12x26x13 ft. Booster Pump building in Box Elder Gulch, and construction of seven 10x16x8 ft. Dewatering/Reinjection Well Houses which were started in 1979 and completed in January, 1980.

RBOSC set up and constructed roofs over a four trailer complex for Mine Dry Houses (completed in February, 1980) and a three trailer complex for Process Maintenance Shops (completed in August, 1980). This complex is shown in Figure 5-6-4. Also constructed was a Floating Process Water Pump Station in the West Retention Pond in August, 1980. Two trailers were set up and decked west of the Process Area. One of these trailers was a Process Dry House and one was for additional process offices (completed September, 1980). A six trailer (14x70 ft.) complex, in Corral Gulch, was established as the Bachelor Emergency Quarters and completed in October, 1980. This trailer complex is shown in Figure 5-6-5. The warehouse was expanded by utilizing a five trailer van complex with a 40x40x16 ft. receiving area enclosure. A five trailer Lurgi complex was started (late November) on the North Mine Bench next to the Mining Fabrication Shop. This project will be completed in early 1981.



FIGURE 5-6-1
SERVICE ESCAPE HOIST AND BUILDING



FIGURE 5-6-2
INSTRUMENT HOIST AND MULTIPLEXER BUILDING



FIGURE 5-6-3
MINING OFFICE BUILDING



FIGURE 5-6-4
PROCESS MAINTENANCE SHOPS



FIGURE 5-6-5
BACHELOR'S EMERGENCY QUARTERS

SECTION VI

ENVIRONMENTAL PROTECTION, HEALTH & SAFETY

CHAPTER 1

INTRODUCTION

This section contains discussions on the following areas: Health and Safety; Fire Prevention and Control; Air Quality Control; Hazardous Waste Control; Land Rehabilitation and Erosion Control; Solid Waste Control; Fish and Wildlife Management Plan; Protection of Objects of Historic and Scientific Interest; and Subsidence Control. Water quality control was discussed in Section 5, Chapter 3, and will not be repeated in this section. Detailed information on the experimental revegetation section, is included in the MDP Monitoring Report 7 submitted to the OSO under separate cover.

Actual construction and operation provided additional information on materials, environmental control, and health and safety activities. Changes were made in various areas as a results of this experience. These are discussed within the individual chapters.

2.1 GENERAL HEALTH AND SAFETY PRACTICES

During the year MSHA compliance training and additional training was conducted on Tract C-a by six MSHA certified instructors. The formal required training program was approved by MSHA and was slightly revised and reapproved during the year.

The six, on-site, trained and certified instructors teach the following courses: Mine Rescue; Mine Emergency; Accident Prevention; Hazard Awareness; the use of Self-Rescue Unit; Flame Safety Lamp; Mine Gas Detection; Oxygen Analyzer; Dust Control; Noise Control; and First Aid and Cardio Pulmonary Resuscitation.

The mine rescue and mine emergency procedures were covered in Section 2, Chapter 4.2, Mine Safety.

During the first quarter, the upper level of the Mine Rescue Building was rebuilt to provide offices and a large training room facility.

All mining personnel were given a special two-hour training class before the Retort Zero ignition. Special hazards were explained as well as the retorting process and other subjects pertinent to operations during the burn.

Also during the first quarter, a contract was finalized with Dr. John Triplett to serve as "Physician Advisor" and sponsor the two Tract C-a ambulances. Eight Emergency Medical Technicians (EMT's) provide full-time, seven-days-a-week, 24-hours-per-day, coverage for Tract C-a. The EMT's are trained at least one day per month by the Physician Advisor.

Inspections by the Safety Department are made daily to help ensure work place safety and compliance with state and federal regulations. Safety violations

are written up by M-K and RBOSC safety inspectors and presented to the appropriate contractor. These inspectors follow through to make sure the violations are corrected.

A weekly reporting system has been established with all contractors which enables the Safety Department to receive timely and accurate information regarding plant safety training, accident treatments and safety meetings. Accident statistics for the site, by contractor, are updated monthly. All accidents are immediately investigated to find causes and remedies.

The OSO conducts inspections on a regular basis. In addition, MSHA has made numerous inspections on Tract C-a during the year.

The incidence rate is calculated as follows:

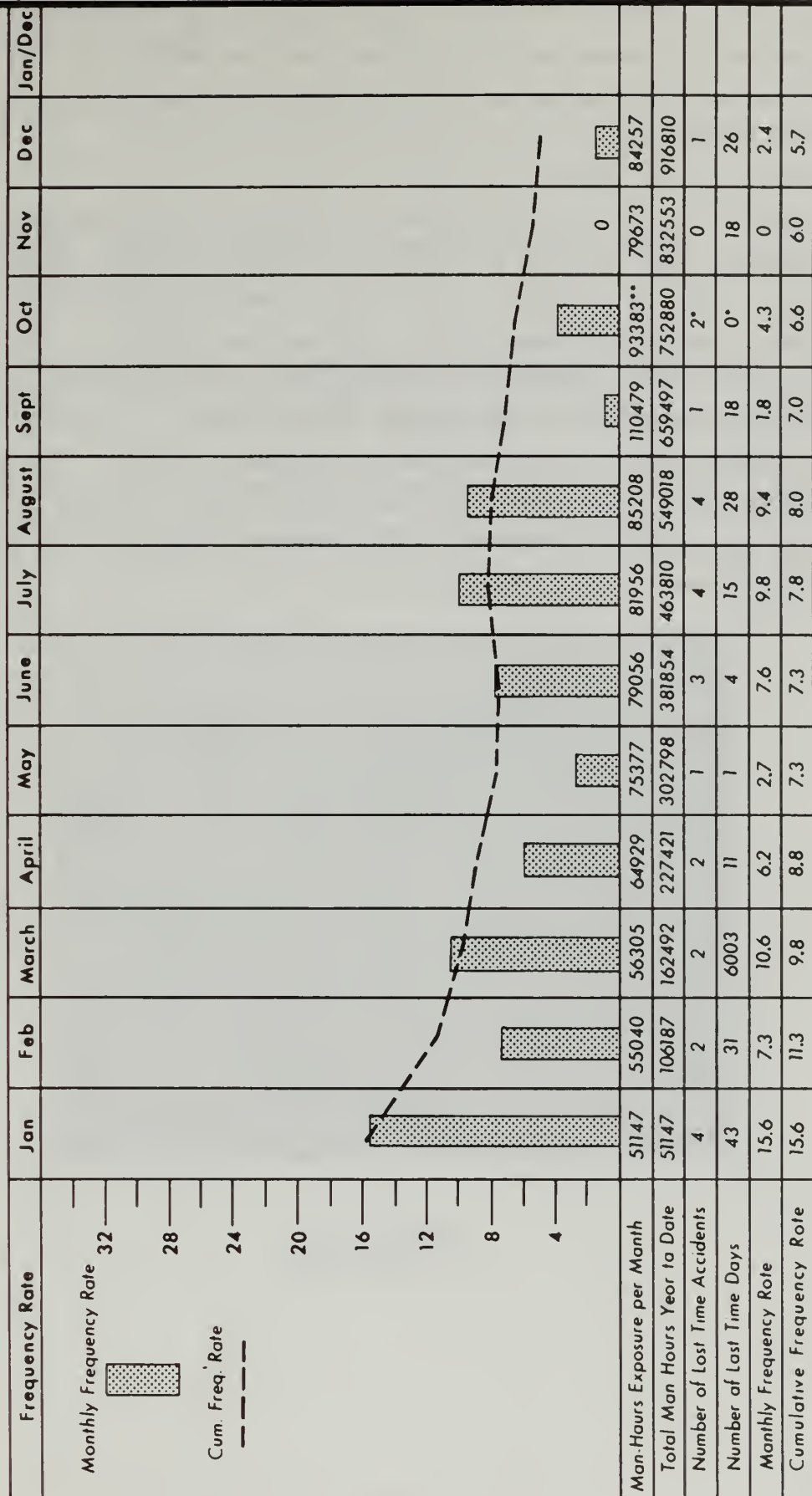
$$\text{Incidence Rates} = \frac{\text{No. of recordable injury cases} \times 200,000}{\text{Exposure or Total Employee-Hours}}$$

For the year, there was a total of 26 lost time accidents. The cumulative incidence or frequency rate for Tract C-a (including surface workers) was 5.7 versus comparable MSHA data for the year 1979 (for all metal and non-metallic underground mines) of 7.6.

Accident statistics for Tract C-a for 1980 as shown on Figure 6-2-1.

On March 6, 1980, a fatal accident occurred at the Production Shaft Loading Pocket. After the Skip Tender loaded the first skip for the shift, it is surmised that an uncontrollable flow of muck and water came through the hinged chute access panel just upstream of the rock chute gate. The velocity of the flow must have been very high. The mass of water and rock pushed the Skip Tender over the safety fence and down the shaft 25 feet to a lower landing. He was discovered within five minutes and taken to the Rifle hospital. He died about four hours after the accident.

Rio Blanco Oil Shale Company
ACCIDENT STATISTICS FOR TRACT C-a FOR 1980



Remarks:

Note: (MSHA Accident Frequency Rate) = (Number of Lost Time Injuries) (200,000) / (Number of Manhours Exposure)

* Drilling Contractor Employee (Parker) Smashed Hand - Pending. **Retart "0" Burn Started 10-13-80.

FIGURE 6-2-1
ACCIDENT STATISTICS FOR TRACT C-a FOR 1980

Following the accident, the Skip Tender Station at the Production Shaft Loading Pocket was extensively redesigned and then remodeled. The chute and gate system was also remodeled so any flow of muck and water could be controlled.

RBOSC became a sustaining subscriber to the "Air Life" medical transport service started by St. Mary's Hospital in Grand Junction, Colorado. The helicopter, which is stationed at St. Mary's Hospital, is available seven-days-a-week, twenty-four-hours-a-day. For serious injuries, the helicopter can be on Tract C-a in about 30 minutes and if the accident warrants, a physician can accompany the helicopter to the scene. A lighted helicopter pad was constructed on Tract C-a for all weather landings. The helicopter pad is shown in Figure 6-2-2. The additional medical expense this service represents was justified because of the favorable response time and because of the varied services offered by the large first class hospital.



FIGURE 6-2-2
HELICOPTER PAD

2.2 INDUSTRIAL HYGIENE

During 1980, industrial hygiene surveys for dust were conducted by MSHA, Los Alamos Scientific Laboratories and the Gulf Oil Corporate Safety Department.

In addition, noise surveys were conducted by MSHA, MS&T, and Gulf Corporate Safety Department.

Los Alamos Scientific Laboratories also sampled other fumes and gases. Altogether, this 3-man group spent about 3 weeks on Tract C-a during 1980.

All the above sampling was done in addition to normal MSHA compliance industrial hygiene sampling for such gases as CO, H₂S, and NO_x.

3.1 MANAGEMENT AND TRAINING

Fire Brigade

During the year, a total of 24 men was trained to fill the 18 fire brigade positions. Three crews of six men each are backed up by additional personnel trained for fire brigade work. A total of 21 hours of training was given each brigade member. Over 60 men have been trained on the Scott Air Pak which can be used for fire fighting in a contaminated atmosphere. Over 90 personnel were trained using a demonstration diesel oil fire which was put out by one individual at a time with a fire extinguisher.

Additional fire fighting equipment was purchased this year. In addition, a fire suppression foam chamber was engineered and installed on the 20,000 barrel shale oil tank.

3.2 FIRE PREVENTION AND CONTROL EQUIPMENT AND PROCEDURES

The following outlines the Tract C-a fire fighting system:

- A storage capacity of 500,000 gallons maximum will be reserved in the Fire Water Reserve Tank (formerly denoted as 500,000 Gallon Water Tank) for fire protection water use via the Fire Water Pump House. The West Retention Pond and the Reinjection Water System will be the secondary fire protection water supply. The Fire Water Reserve Tank will have a minimum of 330,000 gallons reserved for fire protection. If necessary, reinjection could be temporarily stopped or reduced to augment the supply of fire protection water into the tank and into the West Retention Pond.
- A diesel-driven pump and an electric-motor-driven pump with capability of supplying 750 gpm at 125 psi water pressure to the tract fire hydrant system are in full service.

- The International Midship Pumper truck is located in the heated Mine Rescue Building and is capable of pumping 750 gpm for fighting isolated fires.
- The Site Fire Plan (as included in the RBOSC Tract C-a Safety and Health Program) was written to reorganize the Emergency Manpower Call-out.
- Tract C-a has a total of twelve fire hydrants connected to either 6 inch or 8 inch diameter pipelines. These twelve hydrants are located throughout the Mine and Processing Plant site. Three of the hydrants in the Processing Plant Area are permanently equipped with turret nozzles mounted on top of the fire plugs for rapid fire-fighting response. Figure 6-3-1 shows a Processing Plant fire-fighting turret nozzle and fire hydrant.



FIGURE 6-3-1
FIRE HYDRANT AND TURRET NOZZLE - PROCESSING PLANT AREA

Underground, the fire fighting system is installed and is very extensive. The MSHA variance to have a fire underground and burn a modified in situ retort were issued in July, 1980. Numerous stipulations in the Variance resulted in an extensive fire fighting system.

Fire doors which close automatically were installed at the G-Level Production Shaft station, the G-Level Ramp to the Production Shaft bottom and the Sub-E-Level Production Shaft station. In addition, a roll-up type fire door was installed at the Escape Shaft station on G-Level and the Escape Shaft station on Sub-E-Level. The roll up type fire doors have water sprays on both sides of the door. All five fire doors are checked every week to insure proper operation.

A fire alarm system has also been installed. Every fire door has an audible and visual flashing light alarm system. The hoistman can also activate the alarms on the methane gas monitoring stations on G-Level. The hoistman can also activate the stench alarm to effectively evacuate the mine in the event of a fire or other emergency.

Fire hose drops were installed on mine water lines on G-Level at eleven strategic locations. Each 100 foot long, 1½-inch diameter hose has a fire hose nozzle. A minimum of 50 gpm at 50 to 90 psi is delivered to all hose drops.

Large capacity (3,000 cfm) fire fighting foam generators are located in the G-Level Product Pump Room and the G-Level diesel vehicle fueling station; both these units are permanent installations. A portable foam unit is located in the G-Level mechanic's shop. The Sub-E-Level mechanic's shop also has permanent foam unit installed which operates automatically.

CHAPTER 4
AIR QUALITY CONTROL

RBOSC continued its dust control measures during 1980, using water sprinkling trucks for applying water as required in the construction and unpaved road areas. A chemical palliative was applied to haul roads and heavy traffic areas. The following lists the amount of water and dust palliatives used in 1980.

1980 WATER AND DUST PALLIATIVE APPLICATION, TRACT C-a

<u>Quarter</u>	<u>Water (Gallons)</u>	<u>Dust Palliative Gallons of Concentrate)</u>	<u>Comment</u>
1	None	None	Snow Cover
2	2,222,200	None	
3	6,680,900	3297 CSS-1 10M Bindtite	Applied on Tract
4	1,047,600	None	Applied on Tract

Burning of slash from the evaporation pond construction area was done in accordance with the Open Burning Permit from the Colorado Air Pollution Control Division.

RBOSC trained field personnel and implemented procedures in compliance with the Resource Conservation and Recovery Act (RCRA) regulation that became effective late in 1980.

In order for RBOSC to comply with RCRA, (regulations effective November 19, 1980) a Hazardous Materials Isolation Area was constructed during 1980. It is approximately 1000 sq. ft. in area with a retaining dike built around the area to contain any accidental spills. Impervious fill was used as a base to prevent leaching into ground water sources. This diked area is located on the western most area of the mine bench. A 2000 gallon tank was also constructed and placed within the Hazardous Materials Staging Area to store waste oil generated on site. This oil is then transported off site to be recycled. A program to identify and segregate hazardous wastes was initiated in late 1980. The Hazardous Materials Staging Area is shown on Figure 6-5-1.



FIGURE 6-5-1
HAZARDOUS MATERIALS ISOLATION AREA

CHAPTER 6
LAND REHABILITATION
AND EROSION CONTROL

6.1 GENERAL

RBOSC was granted a Regular Permit (No. 77-497) and bonded on March 6, 1978, under the Colorado Mined Land Reclamation Act (hereinafter "the Act"). In compliance with Section 116 (1) (a) of the Act, RBOSC is presenting its 1981 Annual Report, which provides information of activities on Federal Oil Shale Tract C-a during the period from March 1, 1980 through January 31, 1981. A summary of the Technical Revisions approved during the reporting period is presented in Table 6-6-1.

TABLE 6-6-1

TECHNICAL REVISIONS REQUESTED AND/OR APPROVED DURING
THE REPORTING PERIOD, MARCH 1980 THROUGH JANUARY 1981

Date Requested	Subject of Revision	Resolution of Request
May 23, 1980	Construction of additional scrubber blowdown ponds and permission to develop rock borrow pits	Approved at June 1980 Board meeting
October 8, 1980	Construction of an access road and powerline to the northern Tract boundary, and placement of various monitoring wells and/or holes	Approval confirmed in CMLRB letter of October 23, 1980

6.2 AREAS DISTURBED DURING 1980

Total new disturbance during this reporting period amounted to 35.3 acres, considerably lower than the 90.0 acres estimated in the 1980 Annual Report. The discrepancy is due to reduced activity in development of the water reinjection system, and reservoir and/or soil pits. The primary newly disturbed areas were the Lurgi access road and the additional scrubber blowdown evaporation ponds (Table 6-6-2). Tract C-a disturbed areas are shown on Figure 6-6-1.

In addition to the newly disturbed areas, several sites were redisturbed during the reporting period. Topsoil material stripped prior to construction of the Lurgi access road was added to the soil storage pile, located in Corral Gulch. This soil material, which amounted to 9,930 cu. yds., was stripped as per depths shown on the soil maps submitted with the aforementioned permit. Redisturbance at this site, which will be reseeded in 1981, amounted to approximately 2.0 acres.

A section of the reinjection pipeline corridor in Corral Gulch near monitoring well T0-2 was redisturbed. This area originally was seeded in 1978 and will be reseeded in 1981. Total redisturbance amounted to 0.1 acres.

Portions of the Access Road Sand Pit remained active for most of this reporting period. However, no new disturbance resulted from this activity. Access to this borrow pit was gained via the old Airplane Ridge Road, portions of which were initially seeded during May, 1979. It is not anticipated that this borrow pit will be active in 1981.

6.3 AREAS SEEDED DURING 1980

A total of 22.4 acres was seeded during this reporting period (Table 6-6-2). Of this total, 18.2 acres were initially seeded with winter rye for stubble mulch purposes during July 3-5, 1980, and 13.7 stubble mulched acres were seeded with appropriate seed mixes during October-November 1980 (Tables 6-6-3 and 6-6-4). A portion of the stubble mulched area (4.5 acres) was inaccessible as a result of snowfall and was not seeded during Fall 1980. These

TABLE 6-6-2. ESTIMATES OF MDP ACRES DISTURBED AND ACRES REVEGETATED ^{1/}

Disturbed Area	Disturbance Magnitude	Acres Disturbed				Acres Revegetated			
		1977	1978	1979 ^{2/}	1980 ^{3/}	1981 ^{4/}	1978	1979 ^{5/}	1980 ^{7/}
Mine Service Area Retention Ponds & Plant Site	Major	48.2	3.2						
Retention Ponds							8.0		
Plant Sideslopes							12.0		
Area Near Hunting Club							2.0	1.0	
Area Between Water Tank and Plant Site							5.0		
Diversion System							3.0	3.0	
Settling Basins			4.2				1.0	1.0	0.1
Equipment Yard			3.4				3.0		
Area Near Substation								1.0	
Access/Service Roads	Moderate	10.0	3.0	0.4	17.0		6.5	6.5	0.5
ROM Disposal Area	Major		12.3				10.0		
Soil Storage (1,2,3,4)	Moderate	4.0	3.0		1.4		3.0	1.3	1.4
Storage A,8,C,D									
Powder Magazine	Moderate	0.9			0.2				
Water Reinjection System	Moderate		12.2	13.8	4.0	15.0	7.0		10.3
Transmission Line	Moderate		0.5		0.7				
Natural Gas Pipeline	Moderate			0.8					
Reservoirs & Soil Pits	Major					20.0			
Access Road Sand Pit			9.5				2.0	5.0	4.5
Hunting Road Clay Pit			4.0	0.9					
Monitoring Facilities	Moderate		0.2		3.5				2.6
Trailer Parking Facility					0.5				0.2
Evaporation Field	Major		7.0						
Scrubber Blowdown Ponds	Major			8.9					
Scrubber Blowdown Pond Pipeline	Moderate			0.05	8.0				1.8
Airplane Ridge Road Relocation	Moderate			1.9					
Old Airplane Ridge Road Segment								8.5	0.8
TOTALS		63.2	62.5	26.8	35.3	35.0	62.5	26.0	22.4

^{1/}Acres revised from 1979 Annual Report based on "as built" survey data^{2/}Includes acres disturbed between February 16, 1979 and February 29, 1980^{3/}Includes acres disturbed between February 29, 1980 and January 31, 1981^{4/}Estimated disturbance for reporting period February 1981 - January 1982^{5/}Areas seeded May 1979^{6/}Area redistributed during 1979 and reseeded in November 1979^{7/}Area seeded October and November 1980

TABLE 6-6-3
AREAS SEEDED AND MULCHED ON TRACT C-A DURING 1980

Disturbed Area	Seed Mixture	Seeding Method	Seeding Rate (lbs PLS/A)	Mulch Type
Soil Storage Pile 4 Outslopes Phase I and II	2	D/H	16/32	Hydro
Evaporation Ponds	3	D/H	25/50	Hydro
Access Road Sand Pit	2	D	16	Stubble
Reinjection Pipeline	1	D	18.75	Stubble
Reinjection Pump Station	1	D/H	18.75/37.5	Hydro
Monitoring Well Pads	1	D	18.75	Stubble
Bachelor Quarters Facility	1	B	37.5	Stubble
Access/Service Roads	1	B	37.5	Stubble
Old Airplane Ridge Road Segment	2	D	16	Stubble

LEGEND

Seed Mixture - See Table 6-6-4

B = Broadcast

D = Drill

H = Hydroseed

TABLE 6-6-4

THE THREE SEED MIXTURES USED FOR RBOSC REVEGETATION ACTIVITIES

	<u>Plant Species</u>	<u>Seeding Rate*</u> (lbs PLS/acre)
<u>Seed Mixture 1</u>	Luna Pubescent Wheatgrass	2.5
	Western Wheatgrass	3.5
	Sodar Streambank Wheatgrass	2.0
	Indian Ricegrass	1.5
	Green Needlegrass	1.5
	Manchar Brome	1.5
	Cicer Milkvetch	1.5
	Madrid Yellow Sweetclover	0.75
	Lewis Flax	1.0
	Winterfat	1.0
	Fourwing Saltbush	1.0
	Bitterbrush	<u>1.0</u>
	TOTAL	18.75
<u>Seed Mixture 2</u>	Yellow Sweetclover	1.0
	Barley	1.0
	Western Wheatgrass	6.0
	Luna Pubescent Wheatgrass	<u>8.0</u>
	TOTAL	16.0
<u>Seed Mixture 3</u>	Yellow Sweetclover	4.0
	Crested Wheatgrass	8.0
	Barley	8.0
	Luna Pubescent Wheatgrass	<u>5.0</u>
	TOTAL	25.0

* Based on drilling rate; rate for broadcasting and/or hydromulching will be doubled.

areas will be seeded during 1981. The areas not stubble mulched (4.2 A) were seeded and hydromulched during the reporting periods. No fertilizers were applied during the reporting period.

The number of acres seeded during 1980 relative to the total newly disturbed acreage was controlled by the type and timing of disturbance. A total of 28.2 acres (e.g. Lurgi Access Road, Phase II Blowdown Evaporation Ponds, etc.) cannot be seeded until disturbance ceases and/or final reclamation of the plant site occurs. Also, some of the new disturbance began in the fourth quarter of 1980 and will continue into 1981. These areas will be seeded in 1981 or as soon thereafter as disturbance ceases.

6.4 STATUS OF ACREAGE SEEDED DURING 1978

Seeding success was assessed quantitatively during late August 1980, using cover estimates within a 1 x 1 m sampling frame placed at 5 m intervals along a permanently established transect within the seeded area. When seeded areas were redisturbed and/or reseeded during 1980, coverage was not quantitatively assessed during this reporting period. Revegetated areas will be surveyed in subsequent years, with cover estimates being taken along these permanent transects at the end of each growing season. Standing crop will be determined during the 5th and 10th years after seeding.

The acreage revegetated in 1978 is listed on Table 6-6-2. A total of 13 transects was established in these seeded areas and, for reporting purposes, seeded areas were grouped into three major categories (soil storage piles, water reinjection system and mine service area). Table 6-6-5 summarizes the cover values by growth form for these three categories.

The soil storage piles that were seeded in 1978 have coverage averaging 26.5 percent, most of which was from the wheatgrass species that were planted. Invading forbs, primarily Russian thistle and crucifer species, accounted for most of the remaining coverage. Russian thistle was prevalent throughout one of the transects but was almost non-existent on the other transect surveyed. The crucifer species were clustered at two of the sampling points rather than being uniformly dispersed.

TABLE 6-6-5
1980 ASSESSMENT OF AREAS SEEDED IN 1978

Area Seeded	Number of Transects	Growth Form	Planted or Invaded	Percent Cover
Soil Storage Piles	2	Grass	P	20.6
		Grass	I	0.2
		Forbs	P	1.0
		Forbs	I	4.5
		Shrubs	P	0.0
		Shrubs	I	<u>0.2</u>
			TOTAL	26.5
Water ReInjection System	4	Grass	P	12.4
		Grass	I	0.2
		Forbs	P	14.0
		Forbs	I	3.6
		Shrubs	P	0.4
		Shrubs	I	<u>1.0</u>
			TOTAL	31.6
Mine Service Area	7	Grass	P	8.7
		Grass	I	0.0
		Forbs	P	12.1
		Forbs	I	3.0
		Shrubs	P	0.1
		Shrubs	I	<u>0.2</u>
			TOTAL	24.1

Plant growth on the water reinjection corridors was good, with coverage averaging 31.6 percent (ranging from 16.9 to 59.3 percent). Planted grasses, primarily the wheatgrass species, and planted forbs (yellow sweet-clover) accounted for 84 percent of this coverage. Invading forbs (primarily Russian thistle) and shrubs accounted for most of the remaining 16 percent coverage. Invading shrubs included rabbitbrush and sagebrush, which are typical of habitats surrounding these reinjection corridors. These corridors were grazed by cattle throughout the growing season.

Transects grouped under the mine service area category included those transects established on pond and mine site slopes and in the equipment yard. Coverage for these different areas averaged 24.1 percent. As in the previous discussion, the planted grasses (specifically the wheatgrass species) and the planted forbs (primarily yellow sweetclover and cicer milkvetch) accounted for most of this coverage. Russian thistle and Chenopodium species were responsible for the majority of the invader coverage. In spite of fencing around these areas, there was some impact from grazing by cattle and/or horses.

6.5 STATUS OF ACREAGE SEEDED DURING 1979

The areas that were revegetated in May and November 1979 are listed on Table 6-6-2. Cover was estimated along 12 transects established in these seeded areas as described in the previous section. For reporting purposes, these 12 transects were grouped into four major categories (soil storage pile, diversion ditches, access roads, and mine service area). The cover values by growth form for each of these four categories are shown on Table 6-6-6.

Plant growth on the soil pile surveyed was very good, with a coverage of 54.8 percent. Planted grass species, primarily the wheatgrasses, and invading forbs accounted for almost all of the coverage. Russian thistle and Chenopodium species were responsible for the majority of the invading forb coverage, and were prevalent along the entire transect.

TABLE 6-6-6
1980 ASSESSMENT OF AREAS SEEDED IN 1979

Area Seeded	Number of Transects	Growth Form	Planted or Invaded	Percent Cover
Soil Storage Pile	1	Grass	P	29.7
		Grass	I	0.5
		Forbs	P	0.2
		Forbs	I	24.4
		Shrubs	P	0.0
		Shrubs	I	<u>0.0</u>
			TOTAL	54.8
Diversion Ditches	3	Grass	P	19.7
		Grass	I	0.03
		Forbs	P	22.0
		Forbs	I	1.7
		Shrubs	P	0.1
		Shrubs	I	<u>0.03</u>
			TOTAL	43.6
Access Roads	6	Grass	P	11.7
		Grass	I	0.02
		Forbs	P	11.5
		Forbs	I	2.4
		Shrubs	P	1.4
		Shrubs	I	<u>0.2</u>
			TOTAL	27.2
Mine Service Area	2	Grass	P	8.5
		Grass	I	0.0
		Forbs	P	7.0
		Forbs	I	0.7
		Shrubs	P	0.7
		Shrubs	I	<u>0.0</u>
			TOTAL	16.9

The diversion ditches that were seeded in 1979 had coverage averaging 43.6 percent. Planted forb and grass species made up the greatest percentage of this total. Yellow sweetclover accounted for most of the planted forbs whereas the wheatgrass species made up most of the planted grasses. Russian thistle was the primary invading forb, but was found along only one of four transects.

Cover on the seeded access roads averaged 27.8 percent, ranging from 12.1 to 41.7 percent. As in the previous discussion, planted grass and forb species accounted for most of the coverage. The wheatgrass species were the dominant planted grass species. The predominant planted forbs were yellow sweetclover and Lewis flax. Winterfat, a planted shrub species, was found consistently in these seeded areas. Russian thistle and Chenopodium species were the primary invading forbs.

As a means of augmenting reclamation success on both the old and new segments of the Airplane Ridge Road, three species of shrub seedlings were planted. Approximately 1950 mountain mahogany, 200 fourwinged saltbush, and 200 rabbitbrush tubelings were planted October 23-25, 1979. Visual inspection of these areas during August 1980 showed seedling success of less than one percent. This extremely low success may be attributed to extensive browsing of these young, tender tubelings by mule deer during the winter. To insure better success in the future, protective measures may have to be implemented.

The lowest coverage value of the areas seeded in 1979 was in the mine service area. Coverage on the outslopes of the retention ponds averaged 16.9 percent. Some impact from grazing was evident even though these areas are fenced. Planted grasses, primarily wheatgrass species, and planted forbs, specifically yellow sweetclover, made up 92 percent of the total coverage. Chenopodium species were responsible for the majority of the invading forbs.

6.6 STATUS OF ACREAGE SEEDED DURING 1980

Seeding success for areas seeded in 1980 was not determined due to late fall seeding. However, permanent transects will be established in these areas and seeding success will be determined after the 1981 growing season.

SECTION VII

SUMMARY—ENVIRONMENTAL & ASSESSMENT & MONITORING

CHAPTER 1
INTRODUCTION

Since its inception in 1974, RBOSC has been conducting extensive environmental data collection programs. Between October 1974 and September 1976, two years of baseline data were gathered. From September 1976 through August 1977, interim environmental data were collected. In September 1977, RBOSC initiated their MDP Environmental Monitoring Program. Data are reported twice a year as listed below:

<u>Report Number</u>	<u>Period Covered</u>	<u>Date Published</u>
1	September - November 1977	February 1978
2	December 1977 - May 1978	September 1978
3	December 1977 - November 1978	March 1979
4	December 1978 - May 1979	August 1979
5	December 1978 - November 1979	March 1980
6	December 1979 - May 1980	August 1980
7	December 1979 - November 1980	March 1981

All monitoring reports are on file in their entirety in the OSO office in Grand Junction, Colorado. A summary of Monitoring Report 7 is presented in this section. Atmospheric, terrestrial, aquatic, hydrologic, special studies, and ecological interaction aspects of the monitoring program are summarized. Detailed discussions and data pertaining to each discipline may be found in the sections of Monitoring Report 7 listed below.

Volume 1 of the RBOSC MDP Monitoring Report 7 contains eight sections as follows:

Section 1	Introduction
Section 2	Atmospheric Studies
Section 3	Terrestrial Studies
Section 4	Aquatic Studies
Section 5	Hydrology Studies
Section 6	Special Studies
Section 7	Ecological Interactions
Section 8	Summary

Volumes 2, 3 and 4 contain appendices as listed below:

2-1	Air Quality Data
2-2	Meteorological Data
2-6	Visibility Data
3-1	Vegetation Data
3-2	Fauna Data
4-0	Aquatic Data
5-1	Surface Water Data
5-2	Groundwater Data
6-2	Revegetation Data

Both air quality and meteorological data were collected during the reporting period. The major event related to air quality occurring within this period was the burning of Retort 0. The maximum concentration of SO_2 (the major air pollutant of concern released from the retort) measured during the burn was 0.022 ppm at Site 1. Since this SO_2 concentration was measured during easterly wind conditions (which would transport the stack emissions in the direction of Site 1), it is quite likely that this measurement resulted from the Retort 0 burn. It should be noted, however, that this concentration is near the threshold of detection of the instrument, being only about four percent of full scale.

The ozone concentrations found on the tract varied from 0.003 to 0.070 ppm, well below the National Ambient Air Quality Standard (NAAQS) for ozone of 0.12 ppm. The diurnal cycle in ozone concentrations was greater at Site 3 than at Site 1. The larger cycle at Site 3 results from nighttime inversions which develop within the gulch in which Site 3 is located. The inversions effectively seal off the gulch from exchange with the rest of the atmospheric boundary layer, allowing ozone destruction reactions to reduce the ambient ozone concentrations at night.

The source of the relatively high ozone concentrations measured at the tract has not been definitely identified, although these concentrations have been found to be typical of many other remote locations. There has been no evidence of local photochemical production from either natural or anthropogenic sources.

Total suspended particulates (TSP) did not exceed the NAAQS during the current year. Multiple and stepwise regression analyses were carried out on the particulate data, using a combination of meteorological and site activity variables. The highest correlations were found using the annual rather than the seasonal TSP data sets. Approximately two-thirds of the annual variability of TSP concentrations could be explained by the meteorological and

site activity variables. This is very similar to the results of regression analyses performed for the two previous years.

Site activity parameters ranked no higher than third in explaining the variability of TSP concentrations, and contributed only minor improvements to the regression analysis. Temperature was by far the most successful predictor, largely because it has an annual cycle similar to the TSP data, and it serves as an indicator variable for other important parameters, such as soil moisture.

Review of the 1980 meteorological data revealed that 1980 meteorology was similar to previous years. Precipitation at the tract averaged approximately 12 inches during the current year. The temperature range of 48 C (-16 C to +28 C) measured during the current year at Site 1 is typical of continental sites. Wind speed at the tract has been relatively low, reaching a maximum of 32 mph at the 10-m level at Site 1. Winds have been predominantly out of the west and southwest.

The 1980 visibility monitoring program indicated a slight increase in visual ranges in the Piceance Creek Basin. The mean annual visual range during 1980 was 85 miles, which compares with visual ranges of 79 or 80 miles measured during the three earlier years of monitoring. There is a large day-to-day variability in the visual range, but this is primarily a result of widely varying meteorological conditions. The maximum visual range measured in 1980, 176 miles, was the highest value in the four years of monitoring. Visual ranges near 150 miles were also recorded during each of the three previous years. These values approach the theoretical limit of visual range in the atmosphere (200 miles).

Two noise surveys were taken during the reporting period. The measured sound levels generally ranged from less than 30 dBA (the threshold of the instrument) to 50 dBA, except near the main construction area (adjacent to the headframe), which averaged 71 dBA. If the measurements taken near the main construction area are excluded, these sound levels are comparable to data taken during the baseline period.

The components of the Terrestrial Monitoring Program examined during the December 1979 through November 1980 reporting period include vegetation type mapping and stress, phytosociological, range production and utilization, browse utilization and condition, small mammal, avifauna, mule deer and feral horse studies.

Color infrared photographs taken during 1980 showed only minor variations from data collected during 1979. Apparent decreases in moisture were noted in portions of Box Elder Gulch and to the north of Dry Fork of Corral Gulch. Apparent increases in moisture were noted on portions of Sagebrush Ridge and to the northeast of the MIS Area. These differences seem to be due in part to variations in photographic processing and/or printing between the two years. Increased herbaceous vegetation on some revegetated areas also was evident. Data seem to indicate that dewatering and subsequent reinjection and/or discharge of water on Tract C-a during the reporting period have not altered, to any large degree, the vegetational communities which were present on tract during the 1979 sampling period.

Phytosociological studies were conducted on 10 transects (5 control, 5 treatment) within the upland sagebrush vegetation type on and adjacent to Tract C-a. Coverage of trees and shrubs averaged 23.6 percent in the control area and 31.6 percent in the treatment area. Sagebrush (Artemisia tridentata) was the dominant shrub on both areas. Density of sagebrush averaged 6060 stems per hectare on the control area and 7190 stems per hectare on the treatment area. Coverage of pinyon pine (Pinus edulis) and juniper (Juniperus osteosperma) was low on both the control and treatment areas. Coverage of herbaceous species was 44.8 percent on the control area and 32.4 percent on the treatment area. Bluegrass (Poa spp) and wheatgrass (Agropyron spp) species were the dominant grasses on both areas. The prominent forbs on the control area were the northern sweetvetch (Hedysarum boreale) and lupine (Lupinus argenteus). The most prominent forb species on the treatment area was Hoods phlox (Phlox hoodii). Statistical comparisons of arcsine transformed coverage estimates for forbs, grasses, shrubs and trees (lumped by

growth form) between control and treatment areas, as well as among transects within each location, showed no significant differences ($\alpha = 0.05$).

Range productivity and utilization studies indicated that production ranged from 73 kg/ha in the pinyon-juniper to 291 kg/ha in the mixed brush vegetation type. Production of grasses exceeded that for forbs in the three vegetation types sampled. Wheatgrass (Agropyron spp), Indian ricegrass (Oryzopsis hymenoides), and bluegrass (Poa spp) were the dominant grasses in all three vegetation types. Composition of forbs among the three vegetation types was variable. Bastard toadflax (Comandra umbellata), false buckwheat (Eriogonum spp), northern sweetvetch (Hedysarum boreale) and lupine (Lupinus argenteus) were dominant in the mixed brush type. Arrowleaf balsam root (Balsamorhiza sagittata) and goldenweed (Haplopappus nuttallii) were the most common forbs in the pinyon-juniper type. The upland sagebrush type had dominant forbs found in both the mixed brush and pinyon-juniper types. These species included milkvetch (Astragalus spp), Comandra umbellata, Haplopappus nuttallii, and Lupinus spp.

Statistical comparisons of range production among transects within respective vegetation types for 1980 indicated that there were significant differences ($\alpha = 0.05$) in grass production for all three types. Forb production was significantly different within the mixed brush and pinyon-juniper types. Comparisons among years (1978, 1979, 1980) by vegetation type indicated that grass production was significantly higher for 1979 and 1980 than for 1978 within all three vegetation types. No significant differences were noted in forb production within any of the vegetation types sampled during the same period.

Forage utilization among the three vegetation types was variable. Within the mixed brush type utilization was relatively constant over three years, ranging from 29 percent in 1979 to 31 percent in 1980. Utilization within the upland sagebrush type increased from 36 percent in 1978 to 40 percent in 1980. A marked decrease in utilization was evidenced within the pinyon-juniper vegetation type, from 48 percent in 1978 to 10 percent in 1980.

Browse studies indicated that the weighted average percent utilization ranged from 1 percent in the upland sagebrush to 10 percent in the pinyon-juniper vegetation type. Utilization in all vegetation types decreased relative to 1979 data and is the lowest recorded in five years of study. Results of statistical analyses using arcsine transformed estimates of leader utilization among years (1978, 1979, 1980) by individual browse species indicate significant differences ($\alpha = 0.05$) in use of serviceberry (Amelanchier utahensis) and mountain mahogany (Cercocarpus montanus) within the mixed brush type; sagebrush (Artemisia tridentata), pinyon pine, bitterbrush (Purshia tridentata), and mountain mahogany within the pinyon-juniper type; and sagebrush within the upland sagebrush vegetation type. All of these species except for mountain mahogany in the mixed brush type had significantly lower leader use during 1980 than during 1978. Variations in utilization between 1980 and 1979 generally were not significant. Lower use in 1980 relative to 1978 may be due to decreases in the mule deer herd size between the two years. The smaller mule deer population combined with the relatively harsh 1978-79 winter season have resulted in the continued decline in browse use since May 1978.

Range condition ratings based on age class and/or hedging class were similar to those evidenced during 1979; however, there is some indication that range condition is improving. Improvements are evident primarily in ratings based on hedging classification, and are probably due to lower browse utilization. Because the RBOSC browse studies are designed to census the same individuals on a yearly basis, one would not expect to find large changes in range condition ratings based on either hedging or on age classification.

The small mammal species most frequently captured during this monitoring period were the deer mouse (Peromyscus maniculatus) and the least chipmunk (Eutamias minimus). These same species also were captured most frequently during baseline studies and in 1979 MDP studies. No change which could be attributed to tract development could be detected in the small mammal population within the study area.

More species and a higher number of birds were seen in the pinyon-juniper habitats than in the sagebrush habitats in both 1979 and 1980. The pinyon-juniper habitat has a more heterogeneous vegetative community structure than the sagebrush habitat and can support a more diverse avifauna population. Commonly observed bird species in the pinyon juniper habitats were the black-throated gray warbler (Dendrocia nigrescens) and the chipping sparrow (Spizella passerina). Commonly observed species in the sagebrush habitats were the Brewer's sparrow (Spizella breweri) and the green-tailed towhee (Chlorura chlorura). Differences in numbers of birds observed between years are within expected normal fluctuations in densities.

Mule deer (Odocoileus hemionus) density, estimated from pellet group counts in the RBOSC study area, has declined from 51 deer per square mile in 1978 to 28 deer per square mile in 1980. This decline is probably a result of the severe winter kill of 1978-79. Effects of this winter kill will probably be evident in the density estimates for several years. The estimated deer density has been highest in the tract development portion of the study area for each of the three years of the MDP. Explanations for this high density are uncertain. Continued study will further the knowledge of the factors influencing mule deer use of one area in preference to another, and this information will then aid in planning reclamation and mitigation efforts on and adjacent to Tract C-a.

Thirteen deer killed by collisions with vehicles were found along Rio Blanco County Road 24 during the reporting period. Signs warning drivers of deer road crossing areas were erected along this road in an effort to reduce this loss.

Twenty four bands of feral horses totaling 120 individuals were counted in the RBOSC study area in January 1980. Ninety-nine horses in 21 bands were counted in 1979. A moderate winter and good foal success probably account for this increase. The removal of horses from the area by the BLM may cause a reduction in the number of horses counted in subsequent surveys.

The Tract C-a area does not provide critical habitat for any endangered wildlife. Bald eagles are commonly seen foraging in the area during moderate

to severe winters. This species ranges over a large part of western Colorado during the winter months. Protected species, such as the golden eagle and the raven, are commonly seen in the area throughout the year.

Physical parameters examined at each of the aquatic sampling stations indicate seasonal as well as annual variability. Few trends or major changes in the physical measurements can be detected from the data. Stations 13 and 14 experienced an increase in the volume of flow which was probably due to operational water discharge into Corral Gulch. As a result, the depth and width of the stream channel and velocity of flow increased at Station 13. Higher turbidity recorded at this location was probably a result of the additional discharge.

Water quality measurements made in 1980 indicate no large changes in White River water quality upstream or downstream from its confluence with Yellow Creek. Examination of the 1980 data, as well as the data collected in the baseline and early monitoring studies, also shows no major differences in the water quality at aquatic sampling stations on or near Tract C-a. All analyses were performed according to EPA standards.

A total of 201 periphyton taxa consisting of 157 diatoms (Bacillariophyta), 26 green algae (Chlorophyta), 1 yellow-green alga (Chrysophyta), 12 blue-green algae (Cyanophyta), 2 euglenoids (Euglenophyta), and 3 red algae (Rhodophyta) was identified from the periphyton collected during 1980.

Mean density values ranged from a high of 10,196 units/mm² at Station 29 to a low of 194 units/mm² at Station 13. Annual variations in periphyton densities occur on a seasonal basis and are directly related to such highly variable environmental parameters as current velocity, temperature, light, spring runoff, turbidity and substrate type. The 1980 density and biomass estimates at Station 13 were generally lower than the 1979 values, but the 1980 estimates for all other stations were higher than in 1979. The 1980 estimates for Station 13 were the lowest recorded since the beginning of RBOSC aquatic studies, probably due to the surface discharge and subsequent substrate scouring which resulted.

During baseline studies, Achnanthes spp. (primarily Achnanthes minutissima) dominated the periphyton at Station 13. Taxa dominant at this station during the 1980 MDP studies but not during the baseline studies were the blue-green alga, Phormidium sp., in the spring, the green algae, Cladophora sp., Microspora sp., Spirogyra sp. and Zygnema sp. in the summer, as well as the red alga, Batrachospermum sp., in the fall. This change in dominant species may have been due to the increase in turbidity and flow of water at Station 13. Differences in species dominance are not uncommon in aquatic communities that have a high degree of variability in environmental parameters such as stream velocity and turbidity.

Stations 20 and 21 on Yellow Creek have spring and fall periphyton communities which appear to be dominated by a group of diatoms whose relative abundance varies annually. The summer trend of green algal dominance at Stations 20 and 21 has increased during the MDP monitoring studies from 1978 through 1980. Station 27 on the White River, upstream from any project influence, has shown changes in periphyton density, biomass and species diversity similar to Station 29 which is on the White River downstream from the confluence of Yellow Creek. Therefore, it appears that Tract C-a project activities are having little or no effect on the periphyton communities of the White River.

Corral Gulch is directly affected by project related activity on Tract C-a. Station 13 is located in an unstable area characterized by fluctuations in flow, silt load and dissolved solids. The macroinvertebrate fauna is indicative of disturbance and is tolerant of such conditions. Station 14 is located in an unstable area where water level and velocity have changed several times due to the breaking of the dam and activities related to its repair. The fauna here, too, is indicative of disturbance.

Yellow Creek is a small creek affected by natural fluctuations in flow and silt load. Stations 20 and 21 have similar macroinvertebrate communities characterized by organisms tolerant of unstable conditions. It appears that Tract C-a activities do not affect the biota of lower Yellow Creek.

The White River does not appear to have been directly affected by mining activities on Tract C-a. The macroinvertebrate communities at Stations 27 and 29 can be described as diverse, stable and normal for a river of the size and location of the White River.

The hydrology monitoring program produces information applied to several needs:

- Stipulations of the lease and conditions of approval from the OSO
- Engineering design input for mine and water handling systems
- Evaluation of the need for environmental mitigative measures
- Permit requirements

Data on surface streams and groundwater have been collected since 1975. The 1980 report year data have been compared to data from previous years to identify and to evaluate any trends. The program includes monitoring at numerous installations, including stream gaging stations, springs and seeps, erosion and sedimentation stations, alluvial and deep aquifer wells, surface impoundments, surface discharges, reinjection system, and dewatering wells. The natural hydrologic and hydrogeologic environment is monitored as well as facilities associated with oil shale activities.

Six USGS stream gaging stations were included in the 1980 monitoring program. Continuous monitor data (flow, specific conductance, pH, and temperature) for 1980 were not available from USGS for this report. Water quality data were available for all but the Dry Fork Station (A).

When compared to the baseline period, differences in water quality observed in 1980 were generally not appreciable, particularly for mean values. Differences noted in specific conductance and concentrations of several major inorganic ions and dissolved organic carbon (DOC) in Corral Gulch (east of tract) may be related to occasional mine water discharges in the Corral Gulch watershed. Similar differences from the baseline were noted in the year-end report for 1979. Multiple analysis of variance (MANOVA) indicated that

surface flow water quality data for the 1980 water year was significantly different from the baseline only for concentrations of molybdenum and DOC.

Springs and seeps data for 1980 were generally comparable to previous observations. Baseline data on water chemistry collected near the existing sampling sites are presently being evaluated for comparison with current data.

Data collected at alluvial wells showed seasonal patterns comparable to earlier observations. Analysis of physical data showed a general increasing trend in pH since the baseline period. Data reported in 1980 were comparable to 1979 observations. The trend in pH is probably due to several factors, including natural variability, sampling errors, and the discharge of upper aquifer water into the alluvial system. The presently observed slightly alkaline conditions are characteristic of western arid regions and the overall magnitude of the change is small.

Statistical analysis of alluvial water quality data showed significant differences between 1980 and baseline years for several constituents. However, with the exception of specific conductance, pH, and magnesium concentration, the overall mean levels during the baseline were greater than the means for 1980. Similar results were noted in the year-end report for 1979.

Upper aquifer data showed increased pH levels and slightly increased conductivity levels since the baseline period. Similar trends were observed for the lower aquifer. Statistical analysis of upper aquifer water quality data indicated that the 1980 report year was significantly different from the baseline for several constituents. However, the 1980 means were less than baseline year means for all of these except pH, calcium, magnesium, and sulfate. The pH in the lower aquifer was also shown to be significantly greater than baseline pH levels.

Several factors (e.g., natural variability, sampling errors, local changes in aquifer chemical equilibria influenced by the presence of wells, and perhaps general equilibria changes due to dewatering) interact to create the observed

changes in the upper aquifer. The changes are considered to be geochemical in nature and not the results of retorting or other development impacts.

Development activities were directly monitored using installations associated with the dewatering/reinjection/discharge system, runoff collection system, and liquid waste impoundments. Where past data on ponds were available, 1980 observations were generally comparable to past observations. The piezometers used to monitor pond seepage were dry by the end of 1980, supporting the conclusion that water previously observed in these was due to natural infiltration from precipitation and not pond seepage.

Surface flow stations during 1980 generally reflected discharges lower than 1979 due to diminished surface discharge from the dewatering system. Conductivity, temperature, and pH levels during 1980 were generally comparable to earlier measurements.

The cone of depression resulting from the dewatering operations was relatively constant throughout 1980. Most of the mine water and discharge from dewatering wells was reinjected during 1980.

Toxicology studies of oil shale and related materials have been and are being conducted to assess the potential health hazards associated with these substances. Studies being conducted by the American Petroleum Institute (API) and the Department of Energy (DOE) are most relevant to RBOSC, as both programs include tests of material from Tract C-a.

In 1976, the API initiated a program to investigate selected toxicological properties of oil shale and related materials. Samples included raw shale from Tract C-a. The first phase of the program is complete and results have been published (Weaver and Gibson 1979). Exposure of test organisms to raw and processed shale dust (two year inhalation studies) showed no evidence of carcinogenesis or progressive fibrotic lung disease. Dermal application of the same material yielded similar results regarding carcinogenicity. Similar dermal tests showed, however, that raw shale oil is highly carcinogenic. It is anticipated that the results of ongoing tests of refined shale oil will show that the refining process reduces this carcinogenicity.

Tests of the teratogenic affects of raw shale, processed shale, and raw shale oil showed no deformities, although some fetal toxicity was noted at the higher doses of raw shale oil. Tests of the mutagenic properties of raw shale oil were positive, weakly positive or negative, and positive in the bacterial assays, mouse lymphoma assays, and cytogenetic assays, respectively.

Tests of the acute oral and dermal toxicity of raw shale oil established respective LD_{50} 's (dose at which 50 percent of test animals die) of 8-10 g/kg and 5-20 ml/kg. Histopathological studies of organisms exposed to toxic concentrations revealed extensive liver damage.

Eye irritation, dermal irritation, and skin sensitization tests involving raw and processed shale dust and raw shale oil yielded generally negative results, with the exception of several minor reversible irritation effects. Application of raw shale oil at 0.5 g/72 hours produced dermal irritation.

The tests conducted under the DOE program have been initiated but results are not yet available.

Experiments were initiated during 1975 and 1976 on three revegetation demonstration plots on Tract C-a. Plots R-1 and R-2 serve to demonstrate reclamation feasibility and species adaptability with varying mulch types, fertilizer applications and plot aspects. Plot R-3 was designed to simulate a processed shale disposal site and to test the effects of a reconstructed soil profile (including capillary barrier over processed shale) on reclamation success. Various seeding rates and mulch types also were tested on plot R-3.

Plot R-1, located on a northwestern exposure, had an average coverage of 40 percent for all species encountered during 1980. Planted grass species, primarily Indian ricegrass (Oryzopsis hymenoides) and wheatgrass (Agropyron) species, accounted for 45 percent of this average. For 1980 data, there were no significant differences ($\alpha = 0.05$) in grass coverage among the 16 different treatment combinations. However, based on four years of data, analyses indicated that coverage of planted grasses during 1980 was significantly higher than for all other years. This increase seems to be related to mulch and/or fertilizer treatments. Straw mulch with netting exhibited significantly higher grass coverage than straw mulch followed by crimping. Plots with no fertilizer had significantly higher grass coverage than those fertilized at the time of sowing.

Coverage of planted forb species averaged 9.8 percent and accounted for 24 percent of total coverage on plot R-1. Lewis flax (Linum lewisii), cicer milkvetch (Astragalus cicer var. Lutana) and yellow sweetclover (Melilotus officinale var. Madrid) accounted for the majority of this coverage. For 1980 data, coverage of planted forbs was significantly higher ($\alpha = 0.05$) on plots fertilized at the time of sowing than where no fertilizer was used; however, there were no significant differences for the other two fertilizer treatments. Comparing all four years of data, 1980 coverage of planted forbs was significantly higher than all other years. Concomitant with this increase, coverage of invaded forbs was significantly lower than for previous

years. Forb coverage over four years of data was linked to mulch and fertilizer treatments. Significantly higher coverage of invaded forbs was evident on plots with no mulch and/or hydromulch as compared to either of the straw mulch treatments. Treatment combinations having either no fertilizer or fertilizer at the beginning of the first year of growth exhibited significantly lower coverage of invaded forbs than plots fertilized only at the time of sowing.

Shrub coverage on R-1 averaged 2.9 percent during 1980. Rabbitbrush species (Chrysothamnus nauseosus and C. viscidiflorus) and winterfat (Ceratoides lanata) were the dominant shrub species encountered. No significant differences in shrub coverage were noted among 1980 data but, comparing the four years of study, shrub coverage was significantly higher ($\alpha = 0.05$) in 1977, 1978 and 1980 than during 1976. Based on these data, coverage of shrubs was significantly higher on the no mulch treatments than for any of the mulch amendments. Coverage was similar for most fertilizer treatments but was significantly higher on plots fertilized at the time of sowing than on those fertilized at the beginning of the first full growing season.

On plot R-2 coverage of all species averaged 37.1 percent during 1980. Planted grasses, primarily wheatgrasses and Indian ricegrass, accounted for 41 percent of average vegetational coverage. No significant differences in grass coverage were noted among treatment combinations for 1980 data. However, coverage during 1980 was significantly higher ($\alpha = 0.05$) than for 1976, 1977 or 1978. Coverage of invading grasses was significantly higher in 1980 and 1976 than during the other two years of study. Differences in grass coverage appear to be related to mulch and/or fertilizer treatments. Significantly higher coverage of planted grasses was noted on plots without fertilizer than on plots fertilized at the time of sowing. Coverage of invading grasses was significantly higher on plots with crimped straw mulch than on those with either no mulch or hydromulch.

Planted forbs on R-2 averaged 8.3 percent coverage, or approximately 22 percent of the total coverage. Dominant species were similar to those encountered on R-1. No significant differences were noted among planted forb species for the different treatment combinations based on 1980 data. Invaded

forb species exhibited significantly higher coverage ($\alpha = 0.05$) on plots with no mulch than those which had been hydromulched. When data for all years were considered, coverage of planted forbs in 1980 was significantly higher than all other years. Coverage of invaded forbs was similar to that during 1976 but was significantly lower than during either 1977 or 1978. Variations in coverage of invaded forbs over the four year period appear to be related to mulch treatments. Coverage on plots with no mulch was significantly higher than on the hydromulched treatment.

Shrub coverage on plot R-2 averaged 6.2 percent for 1980. Rabbitbrush species and winterfat were the dominant shrubs throughout the plot. Based on 1980 data, no significant differences in coverage were noted among the 16 treatment combinations. For four years of data, shrub coverage was significantly higher ($\alpha = 0.05$) in 1978 than for 1976, 1977 or 1980. Coverage during 1976 was significantly lower than all other years. Significant differences noted over four years appear to be related to mulch treatments. Coverage on no mulch and hydromulch treatments was significantly higher than either of the straw mulched treatments.

Coverage of all species present on plot R-3 during 1980 averaged 33.8 percent on the treatment portion and 39.5 on the control portion. There were no significant differences in coverage between control and treatment plots based on coverage of all species. However, when grass species were compared over four years, 1980 coverage was significantly lower ($\alpha = 0.05$) than during 1978 or 1979. Low coverage in 1980 may be due to clipping plots for biomass determinations in 1979. Wheatgrass species and Indian ricegrass were the dominant planted grasses, and their coverage, as well as that of invading grasses, seemed to be dependent on seeding rates. The high seeding rate resulted in significantly higher coverage of planted grasses than the low rate. Invaded grasses, primarily cheat-grass (Bromus tectorum) and crested wheatgrass (Agropyron cristatum), exhibited significantly higher coverage on plots with the low seeding rate than those with either medium or high seeding rates.

Pubescent wheatgrass (Agropyron trichophorum) and green needlegrass (Stipa viridula) exhibited significant differences ($\alpha = 0.05$) between control and

treatment portions of Plot R-3 during 1980. Pubescent wheatgrass appeared to be favored on the portions underlain by processed shale whereas green needlegrass exhibited significantly higher coverage on the control portion. These differences do not appear to be related to differences in soil chemistry and consequently probably are artifacts of the sampling technique rather than the result of differences in the treatment and control plots. Indian ricegrass appears to be favored on plots with hay mulch and/or plots seeded at medium or high rates. Significantly higher coverage of pubescent wheatgrass was noted on plots seeded at the high rate than on those seeded at medium or low rates.

Coverage of planted forb species on R-3 averaged 5.3 percent on control plots and 3.1 percent on treatment plots. Cicer milkvetch was the dominant forb throughout R-3 but Lewis flax and yellow sweetclover also were commonly encountered. Forb coverage (all species lumped over all treatments) during 1980 was not significantly different ($\alpha = 0.05$) from that noted during previous years; however, slight decreases were recorded and are probably due to clipping plots for biomass determinations during 1979.

Based on 1980 data lumped by growth form, coverage for all planted forb species was significantly higher ($\alpha = 0.05$) on plots seeded at low or medium rates than on those seeded at the high rate. Cicer milkvetch, when considered without other planted forbs, followed this trend but the other two planted forb species encountered showed no significant difference in coverage based on seeding rate. Cicer milkvetch also exhibited significant differences between control and treatment substrates. Because no differences were detected in soil chemistry between these substrates, the reasons for variations in coverage are not clear.

Coverage of planted shrub species was 4.4 percent on the control and 3.5 percent on the treatment portion of R-3. Winterfat, fourwing saltbush (Atriplex canescens) and bitterbrush (Purshia tridentata) were common on both control and treatment plots. Coverage during 1980 was significantly lower ($\alpha = 0.05$) than for 1977, 1978 or 1979, and may be due to clipping of plots during 1979. No significant differences in shrub coverage (lumped for all planted species) were noted for mulch and/or seeding rates. However, when

individual shrub species were considered, winterfat had significantly higher coverage on the control plots than on the treatment plots. As noted for other species, this difference in coverage between substrates does not appear to be related to soil chemistry.

No significant differences ($\alpha = 0.05$) were noted between soil samples collected on control and treatment portions of R-3. Analyses included electrical conductivity, boron, fluoride, molybdenum, selenium and arsenic, among others. Data suggest that the reconstructed soil profile is functioning as a satisfactory growth medium and that the capillary barrier incorporated in the profile is inhibiting vertical movement of soluble constituents from Tosco II processed shale into the surface growth medium.

Subsidence monitoring is conducted at Tract C-a to determine if any surface displacement has occurred due to the dewatering effort, retort preparation or burning, or any other unforeseen cause. Monitoring is accomplished by surveys of monuments established prior to retort preparation. All monuments are surveyed for vertical movement every six months and for horizontal movement once a year. Surveys were conducted in June and December of 1980. No monument movement was detected.

The run-of-mine ore stockpile lysimeter study is designed to establish the chemical characteristics of leachate generated from raw shale in the field, and to compare such characteristics with those of leachate generated from raw shale in the laboratory. This comparison will enable a determination of the effects on leachate quality of factors such as percolation rates, wetting and drying cycles, and natural weathering.

The lysimeter study was initiated in June 1980. Lysimeters were installed at depths of 5, 10, and 15 feet. Samples are collected by the USGS after each precipitation event and distributed for analysis. To date, adequate leachate for analysis has accumulated only at the 5 foot level. Results of analysis of approximately 20 liters of this leachate indicated constituent concentrations generally lower than those exhibited by laboratory-generated leachate. This difference may be partially due to the lower average surface area per unit weight of the field shale as opposed to the laboratory shale.

Comparisons of the results of lysimeter leachate analyses to Colorado primary drinking water standards show the concentrations of all trace metals except manganese to be below the standards. Concentrations of nitrate, sulfate, and fluoride exceed the standards, but approximate those exhibited by lower aquifer water at Tract C-a.

The mule deer habitat modification study is designed to determine the feasibility of increasing the wildlife carrying capacity of Tract C-a habitats by application of vegetative manipulation, fertilization, and seeding techniques. Such increases offer a means of mitigating development-related loss of wildlife habitat.

The habitat modification experiment was initiated in October 1980 in Stake Springs Draw on Tract C-a. Two treatment areas were established. Within each area, narrow corridors were chopped in the sagebrush, leaving the vegetation undisturbed between the corridors. Corridors in one area were oriented parallel to the direction of the draw (and most winter winds); those in the other, perpendicular to the same. Half of each area was then seeded with a wildlife-oriented seed mix, and half of each area will be fertilized in the spring of 1981, completing a full range of treatments. Control areas were also established adjacent to each treatment area.

The success of the experiment will be measured by estimating forage production and mule deer utilization. Shrub density and cover and herbaceous cover were estimated prior to treatment, and will be re-estimated after each growing season. Mule deer utilization will be estimated by periodic photographs from an established point. The results of these investigations will be included in future reports.

Precipitation, range production and browse utilization are three interrelated components of the Tract C-a ecosystems. Measured increases in range productivity appear to correspond to changes in the amount and distribution of precipitation. The peak periods of precipitation also appear to correspond to the peak growing pattern of cool season plants. This indicates that precipitation is one of the many limiting factors affecting vegetation biomass.

The decreases in the mule deer population from 1978-1980 correspond with the decrease in utilization of selected browse species in the three vegetation types sampled. Severe conditions during the 1978-1979 winter resulted in a winter kill of the mule deer and subsequent reductions in the deer population. It appears that this population decrease resulted in a corresponding general decrease in browse utilization.

Form 1279-3
(June 1984)

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